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TWELFTH ANNUAL REPORT
of
Pasture Research
in the
Northeastern United States
State College, Pennsylvania
1948

1948

Twelfth Annual Report
ofPasture Research
in the
Northeastern United StatesU. S. Regional Pasture Research Laboratory
State College, PennsylvaniaDivision of Forage Crops and Diseases
Division of Soil, Management and Irrigation
Bureau of Plant Industry, Soils, and Agricultural Engineering
Agricultural Research Administration
U. S. Department of Agriculture
and
The Agricultural Experiment Stations
of the
Twelve Northeastern States
Cooperating

Copies of this report were sent to all organizations involved in the development of the present pasture research program in the twelve Northeastern States, and in addition one copy to the Director of each of the following State Agricultural Experiment Stations-- Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, Virginia, and Wisconsin; three copies to Canada as follows--Dean of Agriculture, University of Saskatchewan, Saskatoon, and Dominion Agrostologist and Main Library, Department of Agriculture, Ottawa; and one copy to each of the following--The Library, School of Agriculture, Cambridge, England; Director of the Welsh Plant Breeding Station, Aberystwyth, Wales; Director of the Swedish Seed Growers Association, Svålof, Sweden; Director of the Waite Agricultural Research Institute, Adelaide, Australia; Librarian, Division of Plant Industry, Council for Scientific and Industrial Research, Canberra City, A. C. T., Australia; Director, Grasslands Division, Palmerston North, New Zealand.

B.

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* This annual report of pasture research
* in the twelve Northeastern States is a
* progress report and as such may contain
* statements which may or may not be veri-
* fied by subsequent experiments. The fact
* that any statement has been made herein
* does not necessarily constitute publica-
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* be published unless permission has been
* granted.
*
* The Report is prepared primarily for the
* official use of forage crop research workers
* in the Region and since it is mimeographed
* in limited numbers it is not available for
* general distribution to individuals outside
* the Region.
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	Page
Introduction	1
Part I	
Cooperative research between state stations and the Laboratory	3
Regional strain testing	3
<u>Dactylis glomerata</u> breeding	3
At College Park, Maryland	3
At Beltsville, Maryland	3
At State College, Pennsylvania	4
<u>Phleum pratense</u> breeding	5
At Durham, New Hampshire	5
<u>Poa pratensis</u> breeding	5
At Morgantown, West Virginia	5
At State College, Pennsylvania	6
<u>Medicago sativa</u> breeding	7
At Ithaca, Churchville, Tully, and 4 Regional Test Plots, New York	7
At New Brunswick, New Jersey	10
At Kingston, Rhode Island	11
At Beltsville, Maryland	11
At State College, Pennsylvania	12
<u>Trifolium pratense</u> breeding	12
At Durham, New Hampshire	13
At State College, Pennsylvania	13
<u>Trifolium repens</u> breeding	13
At New Brunswick, New Jersey	13
At Durham, New Hampshire	14
At State College, Pennsylvania	14
Nutrition Studies (With Pennsylvania)	15
Chemical composition of pasture grasses (With New Hampshire)	16
Pasture management experiments	17
With Pennsylvania (Dairy Cows)	17
With Pennsylvania (Turkeys)	19
Pasture renovation experiments	20
With Rhode Island	20
With Vermont	21
Temperatures at different heights and under various conditions (at State College, Pa.)	22
Maintenance of legumes [With Cornell (New York), New Jersey, New Hampshire, Pennsylvania, Storrs (Connecticut), and the Division of Soil Management and Irrigation] . .	23
Soil fertility and soil moisture in grasslands (With Dela- ware, Maine, New Jersey and Rhode Island)	25

Part II

Research at the Laboratory	26
Cytogenetics and breeding	26
Varietal improvement in <u>Dactylis glomerata</u> , <u>Poa pratensis</u> , <u>Bromus inermis</u> , and <u>Trifolium repens</u>	26
Inbreeding in orchard grass	26
Hybridization and recombination of characters in orchard grass	26

Comparison of clonal and polycross progeny tests for evaluation of individual plants of <u>Dactylis glomerata</u>	26
Reaction of varieties of <u>Dactylis glomerata</u> to systems of management and associated species	27
Response of strains of <u>Poa pratensis</u> to nitrogen fertiliza- tion and height of clipping	27
Comparative behavior of strains of <u>Poa pratensis</u> alone and in mixtures of strains	27
Production of improved strains of Bromegrass	27
Isolation of Ladino clover plants resistant to <u>Sclerotinia Trifoliorum</u>	28
Genetic Investigations	28
Heritable characters in <u>Dactylis glomerata</u>	28
Inheritance of immunity from crown rust in diploid <u>Festuca elatior</u>	28
Inheritance of flower color in <u>Medicago sativa</u>	28
Cytological investigations	28
Origin of aneuploidy in <u>Dactylis glomerata</u>	28
Polycross tests of hexaploid <u>Dactylis glomerata</u>	28
Studies on the origin of <u>Dactylis glomerata</u>	29
Selection in diploid <u>Dactylis Aschersoniana</u>	29
Chromosome numbers in collections of <u>Dactylis glomerata</u> .	29
Interspecific relationships in <u>Bromus</u>	30
Hybridization of <u>Lolium Perenne</u> by <u>Festuca elatior</u>	30
Pathology	35
Studies with <u>Sclerotinia trifoliorum</u>	35
Pathogenicity of monoascospore isolates to Ladino and red clover	35
Effect of <u>S. trifoliorum</u> on species of <u>Trifolium</u> , <u>Medi-</u> <u>cago</u> , <u>Melilotus</u> and <u>Lotus</u>	35
Degeneration in <u>Sclerotinia trifoliorum</u>	36
Susceptibility of some species of <u>Trifolium</u> , <u>Medicago</u> and <u>Melilotus</u> to <u>Erysiphe polygoni</u>	37
Physiology and composition of pasture plants	38
Effects of Isopropyl N-phenyl Carbamate on inhibiting head formations of Orchard grass	38
Field trials	38
Greenhouse trials	39
The responses of <u>Dactylis glomerata</u> - <u>Trifolium repens</u> to nitrogen fertilization, soil moisture, and clipping treatments	40
Reserve studies on grasses	41
Hydrocyanic acid content of <u>Trifolium</u> species	42
Winter killing of Ladino clover	43
Recovery of Ladino clover stolons following desiccation	43

Part III

Pasture research at state stations	45
Connecticut (Storrs)	45
Grassland renovation trials in Connecticut	45

Maine	45
Evaluation of forage plants clones, lines, varieties, and hybrids developed by plant breeding	45
Management practices as they affect the productivity and persistence of Ladino clover-grass associations	45
The carotene, thiamine, and riboflavin content of some grasses and clovers grown in Maine	46
Maryland	46
Pasture renovation studies	46
Orchard grass and Bromegrass for forage with legumes	47
Alfalfa variety test	47
Red clover management to maintain stands	47
Red clover breeding	48
New Jersey	49
Alfalfa variety tests	49
Red clover variety tests	49
Bromegrass strains	49
Alfalfa-Bromegrass management	50
Alfalfa variety-fertility interactions	50
Roughage survey	50
Breeding new winter-hardy, disease resistant and productive varieties of red alsike clover	50
The utilization of pastures in the production of pork	51
All roughage and pasture feeding experiments with dairy cattle	52
Small grains for fall and spring pasture	52
The utilization of potash and nitrogen by Ladino clover under grazing conditions	53
Grasses and legumes for poultry range	53
A study of the response of permanent pasture soils to fertilization in New Jersey	54
Supplemental irrigation on pasture	54
New York (Cornell)	55
Breeding and cytogenetic investigations with the forage plants of New York	55
Strain testing and breeding of forage plants for New York state and vicinity with special emphasis on problems of production during periods of midsummer drought	58
The evaluation of birdsfoot trefoil as a forage legume in New York	59
The effect of stage of growth upon the (1) nutritional value, (2) yield of hay and aftermath, and (3) longevity of stand of the principal forage grasses and legumes	60
The relationship of milk production to herbage characteristics from permanent and rotation pasture mixtures	60
Factors which influence the longevity, seasonal growth and productivity of Ladino clover	60
Herbage quality and quantity for forage species grown under various New York environments	61
Entomology	62
Alfalfa snout beetle investigations	62
Clover root borer studies	62
European chafer studies	63
White grub studies	63
Resistance of alfalfa to insects	64

Rhode Island	64
The response of strains and mixtures of forage plants to grazing	64
Vermont	65
Cytogenetics and breeding investigations with forage legumes	65
<u>T. repens</u> var. <u>giganteum</u> 8n=64 Octoploid Ladino clover. . .	65
<u>Lotus corniculatus</u> var. <u>vulgaris</u> Broadleaf birdsfoot trefoil	66
<u>Lotus tenuis</u> , 4n=24 Autotetraploid, narrow leaf birdsfoot trefoil	66
<u>Lotus uliginosus</u> , 4n=24 Autotetraploid, big trefoil	66
<u>T. medium</u> Zigzag clover	67
<u>T. fragiferum</u> , 4n=32 Autotetraploid Strawberry clover . . .	67
West Virginia	67
Pasture fertilization studies	67
Maintaining profitable stands of alfalfa	67
Ladino clover	68
Mid-summer pasture	68
Seed mixture used	68
Fertilization and seeding	69
Harvesting the crop	69
Yield and protein content of forage obtained in three cuttings 1948	69
Grazing data	69
List of publications	71

REPORT
OF
PASTURE RESEARCH
IN THE
TWELVE NORTHEASTERN STATES
FOR THE CALENDAR YEAR 1948

INTRODUCTION

For convenience in presentation the Twelfth Annual Report of pasture research in the twelve Northeastern States is divided into three parts. Part I is a brief account of cooperative work outlined in project statements drawn up between state stations and the Laboratory. Part II describes research primarily at the Laboratory, and Part III covers forage crop research at the state stations. The project leaders involved were responsible for the preparation of Part I, the Laboratory Staff for Part II and the collaborators were responsible for compiling the material in Part III.

Listed at the end of the Report are publications originating at the Laboratory and those originating elsewhere, citations to which were sent in with progress reports.

Personnel changes at the Laboratory during the year included the resignations of K. G. Brown to accept a position with the Colorado Agricultural Experiment Station and Helen C. Harvey to become Mrs. J. H. Smith. Appointments included Mrs. Sarah Riden and Miss Katherine Kovalenko as agents to assist in the chemical analysis of soils, and J. P. Trimble as part-time agent to assist in the cytogenetic and breeding investigations. Mrs. Hilda Heinly was added to the secretarial staff.

Dr. F. F. Lininger, director of The Pennsylvania Agricultural Experiment Station, was appointed collaborator to replace Dr. C. B. Knott of the Dairy Department. Dr. Lininger is referee on forage crops for the Northeastern Agricultural Experiment Station Directors.

While there was no collaborators' meeting in 1948, 3 committees designated two years ago to consider various aspects of pasture research in the Northeastern States each met some time during the year. The committee appointed to consider nutritional aspects of pasture research did not hold a meeting.

The regional strain evaluation committee conferred June 21 and 22 at Ithaca, New York. Plant materials growing in the forage crop nurseries at Cornell University were inspected and discussed, important characteristics, sought in orchard grass and Ladino were emphasized and a plan for obtaining regional evaluation of important characteristics was

developed. A list was prepared of clonal materials of Ladino, Birdsfoot Orchard Grass, Bromegrass and several other species available for further testing in the Region. A detailed report of the meeting was mimeographed and distributed to persons interested in the conference.

The committee on pasture management other than soils met at New Brunswick, New Jersey, February 9 and 10. A mimeographed report of the meeting was distributed in the Region. The report contained a detailed plan for a regional approach to microclimate studies relative to the growth of forage crops and a list of the equipment needed in such studies.

At a meeting of the Northeastern Soil Research Committee held April 1 and 2 at New Brunswick, New Jersey, steps were taken to merge their Subcommittee on regional pasture soils with the committee appointed by the pasture collaborators to consider soil aspects of pasture management. This merger seems highly desirable in the interest of coordination of effort. Research in pasture soils at the Pasture Laboratory has been appreciably expanded in cooperation with certain state stations and the Division of Soil Management and Irrigation, U.S.D.A. Progress in the new work is described in the first part of the present Report.

PART I

COOPERATIVE RESEARCH BETWEEN STATE STATIONSAND THE LABORATORY

REGIONAL STRAIN TESTING

Data were collected at several experiment stations on the clones distributed in the fall of 1946 (1946 Annual Report, Page 3). From these preliminary data there are indications of differential clone responses at the various stations, and evidence that certain clones appear to be superior over a rather large area of the region. On the basis of data collected at Ithaca, New York, and State College, Pennsylvania, certain clones have been selected from which polycross progeny plots will be seeded in the Spring of 1949 at both places. Included among these are predominately clones that were rated superior at both locations and in addition some clones superior at one location, but not at the other. Data collected from these plots and from continued evaluation of the parental clones should provide information on the significance of differential clonal response at different stations.

DACTYLIS GLOMERATA BREEDING
(WITH MARYLAND AND
DIVISION OF FORAGE CROPS AND DISEASES)

Title: Selection, Inbreeding, and Crossing to Obtain Orchard Grass Strains Adapted Particularly for Pastures in Maryland

Leaders: For the Maryland Agricultural Experiment Station - T. S. Ronninger and A. O. Kuhn.
For the Division of Forage Crops and Diseases - R. E. Wagner.
For the Pasture Research Laboratory - W. M. Myers.

At College Park, Maryland.

Polycross Nursery. A polycross nursery will be established in the spring of 1949. It will consist of 209 selected clones from the polycross nurseries at Beltsville and the Pasture Research Laboratory in 1948. This material is being carried over in the greenhouse.

At Beltsville, Maryland

Polycross Nurseries. The two polycross nurseries established in the spring of 1947 became well established so that selections were made in 1948. One of these nurseries consists of 12 replications of 84 clones selected in 1946 from the breeding nursery and the isolation blocks at Beltsville. The second nursery is composed of 15 replications of 225 different clones from material obtained from the pasture Research Laboratory in the summer of 1946.

A total of 47 selections was made in 1948 from these two nurseries, 34 from the Pasture Laboratory material and the remaining 13 from Beltsville material. Seed from the individual plants of each clone was threshed and weighed separately in order to determine the seed yielding abilities of the various clones. Striking differences were found in this respect. Seed from individual plants of the clones will be composited and planted in a progeny test in the spring of 1949. It is planned to seed all plots in combination with Ladino clover.

Clonal material from all 47 selections as well as additional selections made at the Pasture Laboratory from a duplicate nursery were supplied to Dr. A. O. Kuhn, University of Maryland. These selections together with other material obtained from the Pasture Laboratory will comprise a polycross nursery to be established at the University of Maryland in the spring of 1949.

The present polycross nurseries at Beltsville will be maintained one year longer to follow the performance of the plants selected in 1948 during their third year of establishment and to select any additional plants that appear promising.

Further Selection and Increase of Maryland Strains. Approximately 10 pounds of seed were harvested from the selection and increase nursery of the Maryland orchard grass strains. Prior to harvesting the seed the nursery was rogued of inferior plants. This seed will be distributed in the spring of 1949 to experiment stations interested in further testing the strain.

Strain Trials at the Agricultural Research Center. Plots of commercial, Brage, Beltsville (Maryland strain), and an improved selection from Wisconsin were seeded in a pasture at the Dairy Experimental Farm to determine their comparative performance under pasture conditions. These strains were seeded in mixture with red and Ladino clover in plots 10' x 50', replicated three times. The remainder of the two acre pasture is seeded to commercial orchard grass, red and Ladino clover.

At State College, Pennsylvania

Selection and Evaluation of Plants. Because of unfavorable weather conditions in the fall of 1947 the stands obtained from plantings of 112 clones in 10 replications of 5 plants per replication and of 85 clones in 15 replications were unsatisfactory. Although representatives of all clones remain in the nursery and complete replicates of some clones are available, the data obtained will be incomplete. This planting has been retained, however, to collect whatever data are available from it.

From the 319 clones planted in a polycross plot in the fall of 1946 (1946 Annual Report, Page 5) 81 clones were selected for further testing. In addition 25 new selections were made from the source nursery of approximately 2,000 plants set in the field at the same time. These 106 clones were planted in the fall of 1948 in a new polycross plot with 15 replications.

The unfavorable weather conditions in the fall of 1947 also were responsible for unsatisfactory stands in 4 of the 7 isolation plots (1947 Annual Report, Page 4) planted at that time. These 4 isolation plots were replanted in the fall of 1948. Seed was harvested during the summer from the other 3 isolations. One of these was an early maturing isolation consisting of 7 clones and another a late maturing isolation consisting of 5 clones. Isolation plots were established to provide all possible single crosses within each of these two groups of clones. Seed was harvested in the summer of 1948 from each clone separately within each isolation plot. Seed obtained from the single cross plots will be used in comparison with the seed harvested from each clone in the isolation plot for studies of combining ability in orchard grass.

Strain Trials. In the summer of 1948 again no data were collected from the plots of orchard grass varieties (1945 Annual Report, Page 5). These plots were subjected to close clipping in an effort to reestablish a stand of Ladino clover. If this attempt proves successful, it is anticipated that yield data will be collected from these plots during the summer of 1949.

PHLEUM PRATENSE BREEDING

Title: The Improvement of Timothy by Selection and Breeding

Leaders: For the New Hampshire Agricultural Experiment Station - F. S. Prince, L. J. Higgins, and P. T. Blood
For the Pasture Research Laboratory - W. M. Myers and K. W. Kreitlow.

At Durham, New Hampshire

Selection was continued during the year among the superior families constituting two strains of timothy with a view of making further eliminations in the foundation material of the two strains.

POA PRATENSIS BREEDING

Title: Breeding and Improvement of Pasture Grasses and Legumes
(With West Virginia)
Breeding Kentucky Bluegrass for Improved Pasture Types
(With Pennsylvania)

Leaders: For the West Virginia Agricultural Experiment Station - Collins Voatch and J. G. Leach
For the Pennsylvania Agricultural Experiment Station - H. B. Musser
For the Pasture Research Laboratory - W. M. Myers and K. W. Kreitlow

At Morgantown, West Virginia

Seed Production of Selected Strains. Seed was harvested from the 1947 plantings of the three strains of Kentucky bluegrass that proved

resistant to stripe smut Ustilago striiformis. Since one of these strains has appeared quite superior to the others in vigor, spreading ability and seed production, these strains will be kept separate and their identity maintained in this year's plantings.

Stripe Smut of Bluegrass. The primary object of work on bluegrass smut during the past year has been to test a number of individual plant selections for smut resistance and to work out satisfactory techniques for securing a high percentage of infection. An extensive series of inoculations gave such low percentages of infection on susceptible varieties that no satisfactory conclusion as to the resistance of the various selections could be reached. Since the spores used in the inoculations germinated very poorly, it was decided that some method for obtaining a supply of germinating spores would have to be worked out. Consequently, this problem was investigated before further inoculations were made. The heat treatment method, devised by Dr. Kreitlow, was tried extensively but gave inconsistent and erratic results. A fairly extensive series of experiments with various types of treatments was carried out, and it was found that presoaking the spores in an infusion of horse or cow manure consistently increased the germination of the spores from one or two per cent to sixty to eighty per cent. Furthermore, such treated spores would germinate within 5 to 8 hours after they were dispensed in distilled water, while untreated spores required several days for germination. It was further found that spores presoaked in manure infusion could be rinsed in distilled water and stored in mass under moist conditions for more than 3 months without appreciable decrease in germination. By this means, it is possible to keep on hand a supply of spores that will germinate promptly and consistently.

With this method of obtaining germinating spores, we plan soon to start another series of inoculation tests in hope of securing higher percentages of infection.

Further studies have been made on the cultural characteristics of the fungus when grown on artificial media. It has been found that the growth and sporulation of the different cultural types are markedly influenced by the various sources of nitrogen and carbon. Some interesting leads have been obtained which will be followed up in the near future.

At State College, Pennsylvania

Work on this project at the Pennsylvania Agricultural Experiment Station has been temporarily discontinued. Similarly, no further work is being done at present on this project at the Laboratory, except for the production of additional seed increases of strain 143 (223).

MEDICAGO SATIVA BREEDING
 WITH CORNELL (NEW YORK), NEW JERSEY,
 RHODE ISLAND, AND THE DIVISION OF
 FORAGE CROPS AND DISEASES

Title: Breeding Improved Alfalfa for the Eastern United States.
 Breeding and Testing Alfalfa for Pasture and Forage.
 Alfalfa Breeding.

Leaders: For the Cornell University Agricultural Experiment Station -
 S. S. Atwood, R. P. Murphy, H. A. MacDonald, Paul Grun,
 L. J. Tyler, G. G. Gyrisco, and E. D. Donnelly.
 For the New Jersey Agricultural Experiment Station -
 Warren R. Battle and G. H. Ahlgren.
 For the Rhode Island Agricultural Experiment Station - T.
 E. Odland
 For the Division of Forage Crops and Diseases - H. M.
 Tysdal
 For the Pasture Research Laboratory - W. M. Myers and
 K. W. Kreitlow

At Ithaca, Churchville, Tully, and 4 Regional Test Plots, New York

All of the 1948 data from this project have been summarized previously in tabular form in the 1948 Annual Report of the Uniform Alfalfa Nurseries. Only brief summaries of these results will be included here.

1945 Clonal Nursery. During August and September, 1948, notes were taken on the surviving plants in the Katola-farm nursery, which had suffered severe competition from weeds. In December, 1948, 39 plants, showing the best persistence, vigor, and resistance to both diseases and insects, were dug and brought into the greenhouse, where cuttings will be made for a replicated planting in 1949.

1946 Clonal Nursery. Good hay and aftermath growth were obtained in 1948 from the McGowan farm planting. Notes were recorded on per cent survival, vigor (4 times), number of flowers, leaf spots (twice), leaf-hopper yellowing (twice), and black stem. The better clones in regard to vigor were C-8, 10, 11, 12, 13, 14, 20, 27, 40, 45, 46, 53, 59, W-11, 20, 28, and M-11. The better clones in regard to persistence were C-3, 10, 14, 16, 18, 20, 27, 43, 46, 49, 50, 51, 53, W-10, 12, and M-34.

1947 Clonal Nursery. The planting on the Tailby farm grew poorly throughout 1948. A severe black stem infestation was noted in August, and good notes were recorded in the fall, in cooperation with Dr. Tyler, particularly on leafspot and mildew on the leafspot resistant clones and seedlings obtained from Dr. F. R. Jones. When one of these clones was found to be severely infected, material was sent to Dr. Jones for further observations on the possibility of physiologic races of the organism.

1948 Clonal Nursery I. This nursery, transplanted in June, 1948 on the Lampkin farm, consisted of 82 C clones and 36 New York selections (mostly from the seedling flats grown in 1947 in the 1945 clonal nursery), with 3 cuttings per plot, each cutting spaced 3' x 3' in a randomized block design with four replications. Good notes were obtained in September and October, after dusting with DDT, on vigor, leafhopper yellowing, leaf spots, and mildew.

1948 Clonal Nursery II. This nursery, planted adjacent to Nursery I and handled in the same way, included 204 recent New York selections (from both old fields and the 1944 source nursery) and the 12 C clones that are used in the 3 1947 synthetics for comparison. Notes similar to those taken on Nursery I were taken here also.

Selections in 1946 Source Nursery. On the basis of several notes taken during 1946, 1947, and 1948, 92 plants were selected for transplanting into a replicated clonal nursery in 1948.

Selections for Selfing and Diallel Crossing in 1948-49. Ninety outstanding clones, particularly from the 1946 and 1948 clonal nurseries, have been brought into the greenhouse for selfing, and in the case of the 17 clones that showed the greatest superiority in specific characters, all possible single crosses will be attempted within groups.

<u>Group</u>	<u>No. of Clones</u>	<u>Superior Characteristics</u>
1	5	Persistence
2	5	Leafspot resistance
3	7	Leafhopper resistance
4	5	Blackstem resistance
5	10	Vigor
6	5	Best

Leafspot and Wilt Resistance. A thesis study has been begun by Mr. Donnelly, using material especially adapted to New York, to determine the best inoculation techniques for large populations, and to determine the inheritance of resistance to these diseases, if possible.

1945 Observation Nursery. Because of excessive weed growth and poor stands, no notes were taken on this planting in 1948 and it was plowed during the summer.

1946 Observation Nursery. Two crops were harvested for yield, on July 9, 1948 and August 28, 1948, respectively, and notes were taken in this nursery on spring growth (5/23); density and vigor (7/22); and lodging, amount of flowering, and leaf spot (8/25). Highly significant differences in yield were found in both of the crops and the total. So far these data have not been summarized to show the general and specific combining ability of the six clones included in all possible combinations in this nursery.

1947 Observation Nursery. This nursery was cut for yield, similarly to the 1946 Observation Nursery, and the same characters that were noted

there were noted here. In addition, leafhopper yellowing was noted here on August 25, 1948. The differences in yield between varieties were highly significant at both crops. The outstanding clone in both polycross and single cross performance was C-53.

Churchville Plots. This planting, made in April, 1946, combined parts of both the 1945 and the 1946 Advanced Nurseries, together with a few entries from other sources. Highly significant differences between varieties were observed for yield at the first crop, the second crop, and total, as well as for the 4 characters noted: flowers, wilt, vigor, and stand. In 1948, Atlantic was the highest yielding variety in the test, replacing some of the single crosses that were highest in 1947. The second crop was removed early (August 5, 1948) with the expectation that a third crop might be obtained. Because of dry weather and a severe leafhopper attack, however, so little regrowth was made that it was not removed for yield. In this regrowth distinct wilt symptoms were common throughout most of the plots. The 1949 yields may be influenced even more by wilt than were the 1948 figures. Ranger performed well and Ranger, Atlantic and several single crosses have maintained good stands. Several of the northern variegated strains, Buffalo, Kansas Common, and Oklahoma Common, have reduced stands. Grimm #666 and Grimm #451 from Saskatchewan showed marked reductions in stands in October.

Tully Plots. The seeding of 35 varieties at Tully, in 4 replications alone and 4 with brome grass, made on June 10, 1947, was harvested twice for yield in 1948. Excellent stands and growth were obtained for all varieties; the differences between varieties were significant only for the first crop of the plots grown with brome. The most outstanding variety in regard to yield was Narragansett. It ranked first in the hay yields, both alone and with brome; it also ranked first in the aftermath crop with brome, and was exceeded only by one lot of Ontario Variegated in the aftermath crop grown alone. Narragansett also showed some resistance to leafspots.

Katola Plots. Only one crop was harvested in 1948 from the plots seeded on June 23, 1947 on this poorly-drained, non-alfalfa soil, but the yields seem to be indicative of the ability of the varieties to persist on this type of soil. The yields for the respective varieties were: Ranger, .42; Buffalo, .67; Ontario Variegated, .67; and Atlantic, .78.

Regional Plots. In cooperation with Professor Johnson, a trial of Atlantic, Buffalo, Ontario Variegated, and Ranger, both alone and in combination with each of 3 varieties of brome grass, was seeded in 1947 in Columbia County. The Yields in 1948 showed no significant differences between varieties. The first crop was injured with leafspots, leafhoppers, and weeds, and the second crop was badly damaged by grasshoppers. Trials, in St. Lawrence, Montgomery, and Onondaga Counties were seeded in 1948, and all of these included Narragansett in addition to the above named varieties. Good establishment was noted on all of these plots in September, 1948.

Other 1948 Plantings. The principal other alfalfa plantings in 1948 were: (1) a plot, and spaced plant evaluation of Syn.-1 through Syn.-3 generations of Ranger produced at different locations, (2) a row and spaced plant evaluation of the 3 synthetics A-224, A-225, and A-226, comparing in each case the bulked Syn.-1 from 1 or 2 locations with wide polycross and the narrow polycross (harvested from the Syn.-1 production field) of each constituent clone, (3) a 1948 Observation Nursery, and (4) an Advanced plot nursery. Several notes were taken on this material, particularly with the spaced plants, but summaries have not yet been completed.

Greenhouse Tests of Pea Aphid Resistance. During the winter 1947-48, Prof. Gyrisco tested for their resistance to pea aphids 191 of the clones that are in the 1948 Clonal Nurseries I and II. Two cuttings were tested for each clone by enclosing each cutting in a cage with ten apterygotous adults, all reared from a single stem mother. Results were measured in plant growth and in number of aphids after 7 days. Large differences between clones were observed. The testing is being continued and extended to include other insects.

Greenhouse Sterility Studies. From the intercrosses and backcross made during 1947-48 with six families, no clear-cut evidence of intra-sterile, inter-fertile groups was obtained. It seems reasonable to conclude that with the material tested so far, there would be little possibility of isolating S alleles that could be used to produce double cross alfalfa. Among some crinkled-leaf plants, however, there was found a male sterile plant, and it was crossed to produce F_1 plants for study, during 1948-49. If this character is simply inherited, it might be of great practical use in producing double cross hybrids.

Cytological Studies. The study of meiotic pairing has been continued, using Feulgen-stained permanent flower bud sections. While as many as four quadrivalents were occasionally found, the average frequency in different plants ranged from around 0.2 quadrivalents to 0.9 quadrivalents per cell. Similarly the univalents varied from around one per cell to as low as 0.3 per cell. In both cases the frequencies were strongly influenced both by date of collection of the material and the plant x date of collection interaction. Percentage of cells in different plants containing laggards at first telophase varied from 6 to 21, and in the second telophase from 12 to 32 per cent. While pollen sterility values of from 6 to 40 per cent occurred in normal material there was no apparent relation between it and laggard frequency.

At New Brunswick, New Jersey

Fifteen seedling plants of each of the thirty-seven lines which were composited to form Atlantic, as well as the same number of 21 additional lines, were inoculated with wilt and established in the field during the Fall of 1948. Notably wilt-susceptible lines will be eliminated, and the remaining ones recombined in an attempt to develop a variety with the same wide adaptation as Atlantic, but with greater wilt resistance.

A new advanced nursery consisting of 21 lines and varieties in 5-row plots replicated 4 times, was established in the Spring of 1948. A single cutting was taken this season. No significant differences between yields of strains were noted.

Observations on plants artificially inoculated with the alfalfa wilt organism indicate that four or more years may be necessary in some cases in order to determine true resistance to the disease. Twenty clonal cuttings of each of a number of lines were artificially inoculated and established in the field. One such line (C140 N.J.) appeared extremely vigorous and completely free of wilt until the fourth season of growth, at which time all cuttings suddenly developed marked symptoms of wilt and many have since died. Most of the other lines had died from the effects of the disease in the first year or two, but one line (C141 N.J.) still has shown no indication of wilt infection.

At Kingston, Rhode Island

Two advanced test nurseries and one polycross nursery were used in the alfalfa breeding program in 1948. Another advanced nursery planted in the fall of 1947 was discarded because of the poor stands obtained. A new advanced nursery was planted this year. Additional material was also added to the polycross nursery. Seed from the polycross nursery will be planted in the Greenhouse for individual plant study.

The outstanding hybrids again this year were 57-C24, 57-C41, 57-C21, and 57-C48. These are included in the nursery planted in 1946. In the nursery planted in 1945, Nebraska 49-1282, Nebraska 39-1272, and Narragansett produced the highest average yields.

The season was exceptionally favorable this year for alfalfa seed production locally. About 30 pounds of Narragansett seed were obtained from a small 1/8 acre plot. No satisfactory arrangement has been reached for continuing seed production of this variety in the seed producing areas. This problem of increasing seed supplies of new varieties urgently needs some solution.

At Beltsville, Maryland

Observations of adaptation, including stand longevity, and recording of diseases in field plantings and artificial inoculations for Rhizoctonia, Sclerotinia, Fusarium Wilt, bacterial wilt and anthracnose in the greenhouse are among the chief activities in alfalfa research at Beltsville. Plantings of selected clones for other States as well as a number selected in the local program and from old fields during field trips, together with replicated field plot plantings of polycrosses are used for note taking. Special emphasis is given to leaf, stem, and crown diseases, and leaf hopper yellowing. These, together with vigor, desirability, color of foliage and stand longevity are the chief points recorded. Yield data, at least to date, are not taken on the plots at Beltsville.

For the Greenhouse plantings, the best wilt resistant polycrosses have been established in flats and these flats inoculated with Rhizoctonia. The survivors from the Rhizoctonia inoculation are subsequently subjected

in turn to Fusarium wilt, bacterial wilt and anthracnose. So far this program has been on a relatively small scale, but we would like to stop it up to include many thousands of seedlings. The survival would then be compared in the field with other desirable clones for resistance to other diseases, including leaf spots and leaf hopper yellowing. It is hoped in this way to be able to supply the cooperative program with clones resistant to several specific diseases. During the past year clones C255 and C256 have been entered in the Federal-State Alfalfa Improvement Conference program.

At State College, Pennsylvania

In the spring of 1948, 225 clones were established in four replications of 5 plants per replication. These clones consisted of 45 C clones, including 26 Laboratory selections that had been entered in the clonal exchange, an additional 41 selections made at the Pasture Research Laboratory and tested previously in replicated plantings, 41 selections from old fields in the northeastern region and evaluated as single plants in the nursery, 60 selections from the 1946 alfalfa nursery, and 38 collections made in 1947 from old fields. The 4 replications were arranged in the field in a manner that would permit clipping 2 of the replications at the normal hay stage and the other two replications more frequently to provide a preliminary evaluation of ability of these clones to survive under close clipping.

On the basis of tests at several stations in the eastern region and at Lincoln, Nebraska, C 199, a selection made at the Pasture Research Laboratory, has been taken as one of the 4 clones for use in a new synthetic being developed for the eastern region.

Hybridization and Recombination of Characters. Observations were made several times during 1948 on the 1100 seedlings planted in the spring of 1947 (1947 Annual Report, Page 8). Relatively few of these plants appear to be sufficiently promising to warrant selection. The results indicated that much larger numbers will be required in the segregating progeny to provide recombinations of rhizomatous habit with desirable plant type. Consequently, 6,000 seedlings from F_2 populations of the same source as those planted in the Spring of 1947 were established in the field in the Spring of 1948. As a further step in effecting recombination of desirable characteristics of the best clones, approximately 25 were brought into the greenhouse in the fall of 1948 to be used in selfing and in crossing.

TRIFOLIUM PRATENSE BREEDING

Title: The Improvement of Red Clover by Selection and Breeding

Leaders: For the New Hampshire Agricultural Experiment Station - F. S. Prince, L. J. Higgins, and P. T. Blood.
For the Pennsylvania State College - F. G. Hanson
For the Pasture Research Laboratory - W. M. Myers and K. W. Kreitlow

At Durham, New Hampshire

During the winter of 1947-48, crosses were made among twenty plants representing families with a perennial tendency, that had been selected for disease resistance. Seeds from these crosses are now being propagated.

During the season, seed was harvested from plants that were two, three and four years old. These lots of seed await planting. Testing of this strain along with similar selections from other states, is under way. In addition, seed was harvested from a field of the New Hampshire strain so that enough seed is available for testing in our own state and in other states.

At State College, Pennsylvania

Red Clover Resistant to Sclerotinia trifoliorum. During the past year, more than 90 domestic and foreign strains of red clover have been tested in the seedling stage for resistance to Sclerotinia. Only a few plants have survived in the tests and these have not been restricted to any particular strain or strains of red clover. This indicates possible low seedling resistance in most strains of red clover to the biotypes of Sclerotinia used. Further studies are contemplated with older plants.

TRIFOLIUM REPENS BREEDING

Title: Breeding White Clover for Pasture (With New Jersey)
The Improvement of Ladino Clover by Selection and Breeding
(With New Hampshire).

Leaders: For the New Jersey Agricultural Experiment Station - G. H. Ahlgren.
For the New Hampshire Agricultural Experiment Station -
F. S. Prince, L. J. Higgins, and P. T. Blood.
For the Pasture Research Laboratory - W. M. Myers and K. W. Kreitlow.

At New Brunswick, New Jersey

Progeny Tests of Diallel Crossing System.

Seed Production. The production of seed of three crosses of selected parents, namely 6-5 x 6-16, 6-10 x 6-13, and 6-9 x 6-12, has been continued. About 1/2 pound of seed of cross 6-10 x 6-13 is now available and from 50 to 75 grams of each of the others.

Seed production from the plot where open or close pollination is being practiced has been continued and a small supply of this is also available.

Field Plot Tests. Small plots replicated two times as seed was available were established in the fall of 1947. The dry matter yields from these plots are presented in the table below.

Comparative Yield Data
for 1948

Strain or hybrid	Dry matter in pounds per 60 sq. ft.			
	June 24	July 30	Sept. 3	Average
Ladino (Comm.)	3.19	3.30	1.40	2.63
6-9 x 6-12	2.67	3.33	2.34	2.78
6-10 x 6-13	3.22	3.48	2.10	2.93
6-5 x 6-16	3.44	3.83	2.14	3.14
Ladino (Comm.)	3.69	3.81	2.40	3.30
Close-pollinated	3.33	3.33	1.67	2.78
6-10 x 6-13	3.05	3.68	2.42	3.05
6-5 x 6-16	3.90	3.83	1.74	3.16
Close-pollinated	3.30	3.58	1.75	2.88

While these data are preliminary and inadequate as yet there is some indication that close-pollination is not as successful as the production of hybrids in securing high yields. The commercial Ladino yielded about as well as any of the other plots although the hybrid 6-5 x 6-16 appears very promising.

At Durham, New Hampshire

Intercrossing among selected plants was continued during the winter of 1947-48. Seed obtained in previous crosses was propagated along with seed produced under a cage during the 1947 season. In all, a total of 800 plants was thus produced in a spaced nursery during the summer of 1948. These plants were rated as individuals and as families for vigor, leafiness and other characteristics. Parent material is being held in the greenhouse this winter along with outstanding individuals from the 1948 spaced plantings. Because of the moving of our experimental greenhouses this winter, it is unlikely that any further progress will be made by winter work; the greenhouse space which is now at our command cannot be heated and lighted suitably to bring the plants into flower.

At State College, Pennsylvania

Progeny Tests of Ladino Clover Clones. Polycross seed was collected in the summer of 1947 from each of the 103 clones transplanted to the field that spring (1947 Annual Report, Page 11). These 103 clones included 53 LC clones and 50 selections made at the Pasture Research Laboratory that had been tested in 2 previous replicated clonal plantings. From this polycross seed, progenies consisting of 100 plants were planted from each clone in the spring of 1948. These plants became well established and data were taken during the fall of 1948 on size and general vigor. Further data will be taken on these progeny tests during 1949.

Selection and Evaluation of Plants. The winter and early spring of 1948 apparently was unusually severe for Ladino clover. Extensive killing occurred in the polycross plot of the 103 clones referred to above. Differences among clones in survival and in vigor later in the season were

highly significant. Among the 103 clones only 18 were rated as superior. Three of these were LC clones and 15 were from the 50 new clones. Three of the new clones proved to be superior to LC 46 which has been outstanding in previous tests at the Laboratory. The results suggest that great progress can be made in preventing loss of stands of Ladino clover by breeding superior strains. As a test of this possibility, 5 of the best clones and 5 of the poorest clones among the 103 were established in the greenhouse in the fall of 1948. It is planned to cross the 5 best in all possible combinations and the 5 poorest in all possible combinations to provide single crosses for field testing.

From the progeny tests established in the spring of 1946, 228 new selections were made, increased in the greenhouse in 1947-48 and planted in a replicate polycross block with 10 replications in the spring of 1948. As a result of drought immediately following transplanting, establishment of this nursery was unsatisfactory and it will be replanted in the spring of 1949.

NUTRITION STUDIES

Title: Measurement of the Nutritive Value of Pastures and of Pasture Plants.

Leaders: For the Pennsylvania Agricultural Experiment Station - R. W. Swift and J. B. Washko.

For the Pasture Research Laboratory - J. T. Sullivan and V. G. Sprague.

Through the cooperation of the Department of Agricultural Engineering a hay drier was designed for use in this project. Construction was begun early in April and the first test was conducted on May 17 using freshly cut orchard grass. After some modification, the drier was used in the drying of four grasses, namely, Kentucky bluegrass, orchard grass, brome grass, and timothy. The first forage cut was the Kentucky bluegrass at a stage when the head had emerged from the boot but had not expanded. The other 3 grasses were harvested at a comparable stage of maturity. Each of the six plots of these three grasses produced enough hay for a feeding trial with four sheep. It was necessary to combine the cuttings from the 6 replicate plots of bluegrass to secure enough material. A second cutting of this grass was obtained on June 24 from the 6 plots to be used in another feeding trial. Also, a third cutting of orchard grass was obtained August 2 and 3.

The nutritive evaluation of these forages is now under way. Total yields were not recorded as casual observation revealed that many of the plots were in need of nitrogen. Yield data may be secured later under conditions of adequate fertilization. The urgent need for equipment and labor in harvesting and drying of these crops is being stressed.

CHEMICAL COMPOSITION

Title: The Chemical Composition of Pasture Grasses (with New Hampshire)

Leaders: For the New Hampshire Agricultural Experiment Station - T. G. Phillips and T. O. Smith

For the Pasture Research Laboratory - J. T. Sullivan

Studies have been continued on grass samples collected from small plots at State College, Penna. Chemical analyses were made partly at the Pasture Research Laboratory and partly at the New Hampshire Station (1947 Annual Report, Pages 14-15).

In six species sampled at silage and/or hay stages during 1947 fructosan was present in only three, Kentucky bluegrass, timothy and reed canary, in traces only in Alta fescue and was absent in tall oat and orchard grasses. Fructosan, lignin, and crude fiber were higher and protein and other extract were lower in hay than in silage-cut samples.

Eight grass species were sampled in the spring of 1948 at various dates depending on certain morphological stages of growth of the plants. A typical schedule of sampling was as follows, for orchard grass:

- May 18, heads half emerged from boot.
- May 26, heads fully emerged from boot.
- June 2, about one-fourth flowers in bloom.
- June 10, seeds in early milk stage.
- June 15, seeds in dough stage.

Protein was in general lower and soluble carbohydrates in general higher in 1948 than in 1947 samples of comparable date and stage of maturity. Protein, ash and crude fat decreased in each species with advancing plant maturity and also, when the different grasses were compared at similar maturity stages, with advancing season. Nitrogen-free extract and lignin (with few exceptions) increased with advancing maturity. On the other hand, both crude fiber and cellulose increased at first with advancing maturity but in some grasses, as tall oat, timothy, Alta fescue, reed canary, and brome, reached maxima at or previous to full bloom and thereafter decreased. "Other carbohydrates" (a term proposed by Crampton and Maynard to include all true carbohydrates other than cellulose) showed increases in all grasses which were sampled during these periods, up to May 25-28. These were followed by decreases up to June 8-14 regardless of the stage of growth, and increases thereafter. These fluctuations show a dependence of carbohydrate content on some seasonal factor as well as on stage of maturity. Red top was an exception to the last in that "other carbohydrates" decreased steadily during its period of sampling, all of which was on or after June 17. Red top, in its first harvest year, was characterized by low protein (6.0-5.1%), low soluble ash (4.5-4.0%), the lowest crude fiber (26.0-28.5%), and the highest nitrogen-free extract (53.5-57.3%), of the eight grasses. Timothy, as in 1947, was lowest in protein (7.2-4.5%), lowest in soluble ash (4.5-3.1%), and high in nitrogen-free extract (50.8-56.6%). High protein grasses were Kentucky blue (16.6-8.6%) and Alta fescue (16.2-9.0%).

PASTURE MANAGEMENT EXPERIMENTS

Title: Evaluation of Grasses and Legumes for Hay, Grass Silage and Pasture for Dairy Cattle (With Pennsylvania).

Leaders: For the Pennsylvania Agricultural Experiment Station - C. B. Knodt, P. S. Williams and A. L. Haskins.
For the Pasture Research Laboratory - V. G. Sprague.

Systems of Grazing Management on Orchard Grass-Ladino Clover. The paddocks of orchard grass-Ladino clover on which five grazing management treatments were started in 1945 (1945 Annual Report, Page 18, 1946 Annual Report, Pages 15 and 16 and 1947 Annual Report, Pages 15, 16, 17, and 18) were continued in 1948. Production of fat-corrected milk was lower in 1948 than in previous years (Table E). It is felt that an important contributing factor was a loss of Ladino from all paddocks during the fall and early winter of 1947-48. The extremely dry weather during October 1947 prevented growth and rooting down of Ladino clover stolons. In addition a heavy infestation of field mice consumed the few stolons which were present. In the spring of 1948 there was almost no clover on any paddocks except the continuously grazed paddocks and on these the clover was largely of the white clover type, not Ladino. Later in the spring, nitrogen deficiency as judged by the yellow color of the orchard grass, was pronounced on the paddocks previously low in clover such as those under deferred spring grazing and silage plus grazing. By midsummer all paddocks showed a pronounced nitrogen deficiency.

Reestablishment of Ladino clover from natural reseeding occurred to some extent on all paddocks. Grazing management, however, was an important factor in the establishment of new plants as indicated by botanical separations of the herbage from the paddocks through the season (Table F).

Table E. Production of Milk and Silage from an orchard grass - Ladino clover association under different grazing management treatment systems.

Grazing Management Treatments	Pounds per acre FCM from grazing				Tons per acre Silage 30% DM			
	1945	1946	1947	1948	1945	1946	1947	1948
Early spring + rotational grazing	10,511	8,982	6,524	4,748	-	-	-	-
Deferred spring grazing + rotational grazing	11,457	9,761	7,295	5,047	-	-	-	-
Early spring grazing + silage + rotational grazing	5,272	6,471	5,265	3,283	2.8	1.8	1.1	0.8
Silage + rotational grazing	7,199	4,529	3,585	1,906	3.0	5.2	2.8	3.8
Continuous grazing	10,668	9,537	6,993	4,848	-	-	-	-
Kentucky bluegrass rotationally grazed	9,135	6,157	3,933	2,774	-	-	-	-

Table F. Per cent Ladino clover by weight in the forage samples from the orchard-Ladino grazing management paddocks in 1948.
(Average of 4 subsamples in each of 3 replicate paddocks.)

: Grazing Management : Treatment	: Grazing (or cutting) period during the : growing season			
	: First	: Second	: Third	: Fourth
:	: %	: %	: %	: %
: Early spring grazing	:	:	:	:
: + rotational grazing	: tr	: 0.1	: 4.9	: 11.1
:	:	:	:	:
: Deferred spring grazing	:	:	:	:
: + rotational grazing	: 0.3	: 0.9	: 2.9	: 1.8
:	:	:	:	:
: Early spring grazing +	:	:	:	:
: hay + rotational grazing	: 0.3	: 0.1	: 1.8	: 6.0
:	:	:	:	:
: Silage + rotational grazing	: tr	: 0.7	: 4.2	: 8.3
:	:	:	:	:
: Continuous grazing	: 3.9	: -	: 9.7	: -
:	:	:	:	:
Kentucky Bluegrass				
rotationally grazed*	2.3	4.7	-	6.4

*White clover, not Ladino, in these paddocks

Evaluation of Several Grass-Legume Mixtures for Grass Silage and Aftermath Grazing. The silage plus aftermath grazing paddocks of several grass-legume mixtures (1945, 1946, 1947 Annual Reports) were continued during 1948. During this year the silage yields of the two alfalfa mixtures increased, probably due to a very favorable spring growing season. The silage from the Orchard grass-Ladino dropped considerably (Table G), owing to the loss of the Ladino clover from these plots in the fall and winter of '46 - '47 with subsequent nitrogen deficiency. Milk production also was lower in 1948 than in previous years. The reason for this decrease on the alfalfa plots has not been determined. On the brome-grass-Ladino plots, Ladino clover was poorer than in previous years and on the timothy-Ladino plots much of the timothy had been lost and in one replication had been replaced by weeds.

Wilt disease was prevalent on most of the alfalfa paddocks although it did not seriously affect dry matter yields in 1948. It is probable that the stand of alfalfa will be poorer in 1949. As in each of the previous three years, the orchard grass-alfalfa association produced the greatest amount of milk from aftermath grazing.

Table G. Production of milk and silage from various grass-legume associations managed for silage plus aftermath-grazing.

Plant Association	Pounds per acre				Tons per acre			
	4% FCM from grazing				Silage 30% DM			
	1945	1946	1947	1948	1945	1946	1947	1948
Orchard grass-Alfalfa	4275*	5956	5421	4985	5.6	5.8	5.5	7.7
Orchard grass-Lad.Clo.	9634	5050	4884	2013	4.7	5.7	4.4	3.7
Bromegrass-Alfalfa	3926	5248	4759	4581	8.9	6.5	5.6	6.6
Bromegrass-Lad. Clo.	6526	4780	4903	3066	6.2	5.2	5.0	5.8
Timothy-Ladino Clo.	7523	4157	4964	2886	6.5	5.1	3.9	3.6

*One grazing period is not included for lack of suitable milk cows. Thus, the paddocks were grazed by heifers but the gains in weight are not reported here.

PASTURE MANAGEMENT EXPERIMENTS

Title: Evaluation of grasses and legumes for hay, silage and pasture.

Leaders: P. H. Margolf, E. W. Callenbach, J. B. Washko and V. G. Sprague

Experiment I: Evaluation of an orchard grass-Ladino association for turkey pastures under two systems of grazing management, differing in intensity.

The fourth season of pasturing, the orchard grass Ladino areas were again used in 1948. After four years the Ladino has practically disappeared and we have almost a pure stand of orchard grass. Pasturing began June 2 and continued to October 17. The populations of the areas were 150 and 300 poults, respectively, the same as those used in 1946 and 1947. Both areas were grazed rotationally. All equipment, shelters, feeders and waterers were moved daily and each area grazed required approximately three weeks for a rotation.

The poults were fed in outdoor hoppers a turkey growing mash mixture, whole oats, whole wheat, whole corn, oyster shell and grit.

The turkeys were 12 weeks of age when placed on these areas and were removed when 32 weeks old. Normal growth was obtained from both groups. The average body weights were 23.4 and 23.6 for the males and 12.8 and 13.0 for the females in the low and high intensity grazed areas, respectively. On the area of low intensity of grazing 2580 pounds of turkey was produced, while the areas of high intensity of grazing produced 5112 pounds. Mortality of 6.0 and 6.03 per cent is considered very low for grazing these areas for the fourth successive year. We are planning to use these areas again in 1949 and will continue to use them as long as we can maintain adequate ground coverage of the orchard grass and a reasonably low mortality of the poults.

Randomized sampling of the orchard grass for chemical analysis was made during July and August. Results of the average of 8 analyses from each of the areas shows the protein to be 19.13 and 21.60 per cent for the low and high intensity grazed areas respectively.

Experiment II. To evaluate 6 species of grass grown in association with Ladino clover for preference by turkeys, persistence and productivity.

While turkeys grazed this 2-acre area, consisting of replicate plots of the grasses approximately 33' by 50' for the fourth successive year, no records were kept of yield or preference for any of the grasses. Previous seasons showed turkeys preferred Reed Canary, Orchard, Brome and Kentucky Bluegrass to tall fescue. While tall oat was palatable to the turkeys, this grass failed to stand up under frequent clipping. As a result of these experiments, experimental plots of one acre each of Ladino clover, orchard grass, Kentucky bluegrass, bromegrass and reed canary grass have been prepared and the areas will be stocked with turkeys in 1949. Records will be taken on the number of turkeys each forage species will maintain, the rate of gain and per cent mortality of the turkeys, distribution of pasturage throughout the season and degree to which the five species withstand grazing. This new phase of the research should furnish information on the relative carrying capacity of the 5 species of grasses and legume for the entire season, which of the species are able to maintain a satisfactory stand under frequent defoliation by turkeys and whether there are differences in the forages in nutritive value as pasture for turkeys.

PASTURE RENOVATION EXPERIMENTS

Title: Pasture Renovation Trials in Rhode Island (with Rhode Island).

Leaders: For the Rhode Island Agricultural Experiment Station - Irene H. Stuckey.

For the Pasture Research Laboratory - V. G. Sprague.

The results were essentially the same as those for the summer of 1947 on the plots on the College Farm, but because of drought, the yields were somewhat lower for the season. The mixtures containing tall fescue produced the heaviest weights of dry matter, but were generally unpalatable. The orchard grass mixtures were next in yields and were eaten with relish. The percentages of birdsfoot trefoil had increased on the various plots where it had been seeded but the increase seemed to be due as much to the lesser palatability of this species as to persistence under grazing.

A pond was constructed on the Foster farm and as a result the water table in the vicinity of the renovation experiment was changed considerably. The plots were ankle deep in water during the first two grazing periods, a situation which was not at all comparable to the previous years. As a result of flooding, the orchard grass and Ladino clover showed yellowing and generally low vigor but the smooth bromegrass was as well adapted to wet conditions as reed canary grass. Later in the season, when other places were suffering from severe drought, this area still contained enough moisture to produce even higher yields than for the summer before.

These experiments were discontinued at the end of the 1948 grazing season.

PASTURE RENOVATION EXPERIMENTS

Title: Pasture Renovation Trials in Vermont (With Vermont).

Leaders: For Vermont Agricultural Experiment Station - A. R. Midgley
and K. E. Varney.

For the Pasture Research Laboratory - V. G. Sprague.

Longevity of plants in a renovated pasture. An experimental renovated pasture on a good clay loam was seeded in the early spring of 1943. Table I shows the relative value and longevity of different legumes on this soil after six years.

Table 1. Relative value of different legumes in pasture renovation during six years on addison clay loam (arranged in decreasing order.)

1943	1944	1945*	1946	1947	1948
Red Clo.	Alfalfa		Alfalfa	Ladino	Ladino
Ladino	Red Clo.		Red Clo.	B. trefoil	B. trefoil
Alfalfa	Ladino		Ladino	Alfalfa	Alfalfa
B. trefoil	B. trefoil		B. trefoil	Red Clo.	Red Clo.

*All the plots were reseeded on frozen ground early in the spring of 1945 and kept closely grazed to reduce competition. Therefore, no yield data were obtained.

This table shows that during the first year, red clover gave the highest yields, followed by Ladino, alfalfa, and birdsfoot trefoil. Red clover seldom lives more than two years, but during this time it usually yields well. During the second year, alfalfa took the lead and held it for several years. This plant did remarkably well under rotational grazing on this soil. Ladino clover winterkilled badly the first year, but after reseeding it has taken the lead. Birdsfoot trefoil did poorly at first, but during the last two years it topped the list with Ladino clover.

It is quite likely that Ladino clover would have grown better if there had been more moisture, but on this soil red clover and alfalfa do best in the short rotation while Ladino clover and birdsfoot do best where the land is not worked frequently.

Time of seeding. This work was continued and is to be expanded in the next season because many variables such as soil type and weather conditions play an important part. Birdsfoot trefoil, alfalfa, red and alsike clover seeds were planted at different dates on both a heavy clay and light sandy soil. On the former, an early spring seeding was much better than one in late fall or winter. On the sandy soil the reverse was frequently true. The reason for this difference is not known and more information is needed; perhaps when poorly drained clay soils are seeded in late fall or winter, the seeds swell, remain wet and decompose before it is warm enough for them to germinate. This same result is not so likely to occur on light soils that are drier.

The effect of "hard seeds" on time of seeding is also an important factor. Hard seed is nature's method of insurance against adverse weather conditions at time of planting. Acid treated trefoil seed germinates much better than non-treated seed under ideal conditions, but in the field the reverse is usually true unless growing conditions were ideal. A late fall seeding of most legumes is not recommended because of the high mortality. It is primarily the hard seeds which are dormant in the fall and germinate in the spring, that give such seedings even partial success.

TEMPERATURES AT DIFFERENT HEIGHTS AND UNDER VARIOUS CONDITIONS

The committee appointed to consider aspects of pasture management other than soils suggested that a regional project be set up to study climatic influences on the growth of forage crops. Below are reported the results of some preliminary work at the Pasture Laboratory to determine the effects of various heights of placement of the sensing elements as revealed by a recording resistance thermometer. (This is part of a project with an objective of determining the environments to which forage plants in the field are subjected throughout the year.)

In this trial temperatures taken over bare ground at heights of 0", 1", 3", 6", 12", 24", 48", and 96", were compared with the U. S. Weather Bureau records obtained on top of a building about 1/2 mile distant. The highest daytime temperatures were obtained at the 12-inch level although all temperatures from 1" to 24" were higher than at 96" or at the soil surface. The greatest range of temperatures was recorded at the 12" height and the smallest at the soil surface.

In all cases the thermometer bulb was protected from direct sunlight. The results obtained, however, suggest that the sensing elements should also be protected from radiation from the ground. Further, some inaccuracy was introduced by using the relatively large (1/2" in diameter by 4" long) sensing elements of the resistance thermometer. Thermocouples would be much better adapted for measuring air temperatures although for measuring soil temperatures the larger resistance thermometer elements would be satisfactory.

Temperatures at 96" were within one degree of those reported by the Weather Bureau whereas those at or nearer the soil surface registered a maximum from 1 to 5 degrees higher and a minimum from 1 to 5 degrees lower during the period (August and September) when these readings were taken.

During November and December 1948 air temperatures at 3" above a bare soil, above a Kentucky bluegrass sod and in an Orchard grass sod were recorded with thermocouples. Simultaneously temperatures in white clover stolons and on an orchard grass tiller were recorded. During this period maximum temperatures were not greatly different from those reported by the Weather Bureau but the minimum temperatures over bare soil were several degrees lower. Stolon temperatures on an otherwise bare soil were often higher than air temperature during the day and dropped below air temperature at night. This difference amounted to 34 degrees on November 18, a partly cloudy day. On the same day, a stolon in a Kentucky bluegrass sod ranged from 37° to 55° or a difference of only 18 degrees. Six inches of snow

cover decreased this daily difference to 3 degrees over otherwise bare soil and 1 degree in a Kentucky bluegrass sod. The temperature of 1/8" layer of surface soil varied only slightly as compared to air and plant temperatures.

MAINTENANCE OF LEGUMES

WITH CORNELL (NEW YORK), NEW JERSEY, NEW HAMPSHIRE, PENNSYLVANIA, STORR'S (CONNECTICUT), AND THE DIVISION OF SOIL MANAGEMENT AND IRRIGATION

Title: The Relation of Soil Properties to Persistence of Perennial Legumes

Cooperators: For the Cornell University Agricultural Experiment Station - R. E. Blaser
 For the New York State College of Agriculture Extension Service - Samuel R. Aldrich and County Agricultural Agents W. D. Brown, R. M. Cary, H. E. Johnson, F. P. Howe, E. E. Motsenbocker, R. G. Parker, and T. L. Rawlins.
 For the New Jersey Agricultural Experiment Station - E. R. Purvis.
 For the New Jersey Agricultural Extension Service - C. S. Garrison and County Agricultural Agents D. M. Babbitt and James H. Rice.
 For the New Hampshire Agricultural Experiment Station - Ford S. Prince and Reeshon Feuer
 For the Storr's (Connecticut) Agricultural Experiment Station R. I. Munsell and B. A. Brown.
 For the Pennsylvania State College Agricultural Extension Service - J. R. B. Dickey and County Agricultural Agent B. L. Coleman
 For the Division of Soil Management and Irrigation and the U. S. Regional Pasture Research Laboratory - R. R. Robinson

Areas were selected to afford comparisons between good stands of perennial legumes that had persisted for several years and fields where legumes had not persisted satisfactorily. Although both alfalfa and Ladino clover were included in the study, most of the work was with alfalfa. Fields in which failure of alfalfa obviously resulted from poor drainage were avoided. In fact most of the fields selected were on limestone soils where alfalfa was considered to be well adapted. Data were obtained regarding fertilization, cropping history, and crop management practices. Field appraisals included soil type, profile examination, slope, botanical estimates, root development, symptoms of nutrient deficiencies, and incidence of diseases. Soil samples were taken at 0 to 3 inches 3 to 6 inches and thereafter by horizons usually to a depth of about 18 inches. A total of 114 sites was sampled in New York, 10 in New Jersey, 11 in New Hampshire, 14 in Pennsylvania and 3 in Connecticut. In alfalfa fields that were sampled before the first cutting samples of both alfalfa and of grass were taken.

The soil samples are being analyzed for pH, available phosphate, organic matter total exchange capacity, exchangeable calcium, magnesium, potassium, and manganese, and release of non exchangeable potash. It is also planned to obtain undisturbed cores of soil from a number of these areas for studies of volume weight, pore space, and moisture relations.

The results to date from the field observations indicate that bacterial wilt of alfalfa is present throughout the region and is one of the factors affecting persistence of alfalfa. As would be expected, the incidence of wilt appeared to be greater in areas where alfalfa has been grown extensively. In some fields more than half of the plants were infected. This may partly explain the fact that some of the best old stands of alfalfa were found in areas where alfalfa is not a major hay crop.

It was also noted that in some fields plants infected with wilt consistently showed potash deficiency symptoms. In certain of these fields it appeared that the characteristic potash deficiency symptoms might be the first visible indications of bacterial wilt. In other fields, however, even severely wilted plants showed no evidence of potash deficiency symptoms. In still other cases potash deficiency symptoms were prevalent in fields where very little wilt was found. These observations suggest that the incidence of potash deficiency symptoms on wilt infected plants may serve as a guide to the potash status of the soil. If wilted plants show no potash deficiency symptoms the soil is high in available potash. At lower levels of potash, deficiency symptoms may show on wilt infected plants but not on normal ones. At still lower levels of potash, deficiency symptoms may appear in the absence of wilt.

SOIL FERTILITY AND SOIL MOISTURE IN GRASSLANDS (WITH DELAWARE, Maine, New Jersey, and Rhode Island)

Leaders: For the Delaware Agricultural Experiment Station - Leo J. Cotnoir, Jr.
 For the Maine Agricultural Experiment Station - C. H. Moran, W. C. Libby (J. S. Hardesty and S. Von Day, Soil Conservation Service)
 For the New Jersey Agricultural Experiment Station - E. R. Purvis, W. A. Mitcheltree (G. A. Quackenbush, Soil Conservation Service)
 For the Rhode Island Agricultural Experiment Station - H. C. Allbritten, Irene H. Stuckey and Milton Salomon.
 For the Division of Soil Management and Irrigation and Pasture Research Laboratory - R. R. Robinson

The objective of this investigation is to survey soil fertility levels and soil moisture relations of soils used primarily for hay and pasture. In each state one county or parts of one or more counties were selected for study. A random sample of the dairy farms was obtained and plans made to take soil samples representative of the soils of the farm. Cropping practices, rates of fertilization and estimates of botanical composition are obtained for each farm. In two states soil samples have already been collected and are being analyzed for pH, available phosphate, organic matter, exchangeable bases and rate of release of non-exchangeable potassium. No samples were taken this year for moisture studies.

At Delaware

Preliminary work has been done and arrangements made to sample about 5 per cent of the dairy farms in New Castle County. Soil samples will be taken in the spring of 1949.

At Maine

A section of the Central Maine dairy area has been selected for this study. The sample will consist of at least one per cent of the farms in that area. Preliminary arrangements have been made, including selection of farms to sample. Soil samples will be taken in the spring of 1949.

At New Jersey

Soil samples were taken usually at depths of 0 to 3 inches, 3 to 6 inches and 6 to 12 inches from 88 fields on 12 farms in the western part of Morris County. A total of 246 soil samples were taken. Crop history and fertilizer practices were obtained for each of the farms.

At Rhode Island

Detailed history and general farming practices were obtained for each of the 12 farms surveyed in Washington and Kent Counties. Soil samples were taken at levels of 0 to 3 inches, 3 to 6 inches, and 6 to 12 inches on most of the fields in sod. A few samples were taken from cultivated fields at 0 to 6 inches and from woodland areas by major horizons to a depth of 12 inches. Botanical estimates, general plant vigor and grazing management practices were determined for each area sampled.

PART II

RESEARCH AT THE LABORATORY

CYTOGENETICS AND BREEDING

Varietal Improvement in Dactylis glomerata,
Poa pratensis, Bromus inermis,
 and Trifolium repens

Inbreeding in Orchard Grass. To study the effects of inbreeding upon combining ability a series of plots was planted in the spring of 1948 with polycross seed produced on 52 I_4 lines from 19 families, one to six lines per family (1945 Annual Report, Page 36). In the same planting there was included the polycross seed of each of the 19 parental clones. Yield data will be collected from these plots in the summer of 1949. In addition, space planted I_5 progenies were established from selected plants of each of the I_4 lines to continue these inbred lines. Forty-six I_3 lines consisting of 7 to 30 plants per line were established in the spring of 1948 from selfed seed obtained in 1947 (1945 Annual Report, Page 36).

Hybridization and Recombination of Characters in Orchard Grass. Because of pressure of other duties the material referred to in 1947 Annual Report, Page 28, was not planted in the spring of 1948 as expected. Plans are being developed at present for planting this material in the spring of 1949.

Comparison of Clonal and Polycross Progeny Tests for Evaluation of Individual Plants of Dactylis glomerata. Yields of dry matter were taken at three clipping dates in the summer of 1948 from the clonal and polycross progeny plots established in 1945 (1945 Annual Report, Page 37). The first clipping was made on June 2 when the orchard grass was just starting to flower. Following that, two aftermath clippings were taken. In the early spring nitrogen fertilizer was added at the rate of 60 pounds of N per acre and subsequently N at the rate of 40 pounds per acre was added after each clipping. The mean squares and values of F for comparison of clones and of clones x method of planting with error for each date of clipping and for total are presented in Table 1. The value of F for clones exceeded that for P of .05 in total yield and for P of .01 in the first aftermath and second aftermath clipping. The interaction of clones x method of planting was significant in the first aftermath, but not at the hay stage or in the second aftermath, indicating that in general the polycross progenies of the clones yielded in approximately the same order as did the clones themselves. Since there was a poor stand in many of the plots, estimates were made in per cent of stand and an analysis of covariance of yield on stand was calculated for each clipping. These results also are presented in Table 1. As can be seen, the difference for testing adjusted means was significant at the hay stage and in the second aftermath, but not in the first aftermath or for total yield.

*See Page 31

Reaction of Varieties of *Dactylis glomerata* to Systems of Management and Associated Species. As pointed out in the 1947 Annual Report, Page 28, damage from field mice had brought about the elimination of all Ladino clover from these plots. During the summer of 1948 the Ladino clover plots were clipped frequently in an effort to reestablish it. An excellent stand of Ladino had been obtained in all replications by the fall of 1948. If this stand persists into 1949 it is anticipated that yield data will be collected from these plots during the next year.

Response of Strains of *Poa pratensis* to Nitrogen Fertilization and Height of Clipping. Yields were taken in the summer of 1948 from these plots. The plots receiving nitrogen fertilization were clipped 6 times and those receiving no nitrogen were clipped 5 times. Mean squares and values of F for comparing strains and strains x height of clipping with error are presented in Table 2.* It will be noted that the value of F for comparison of strains with error exceeds that required for P at .05 in all cases, except one, namely, the no nitrogen of the 5th clipping. In general, the value of F for comparison of strains was higher in the nitrogen fertilized series than in the no nitrogen series. This resulted largely from the higher yields and greater differences in yields between strains with nitrogen fertilization. The relative rank of strains in total yield per plot with and without nitrogen at each clipping date is presented in Table 3.** It can be noted that in general the strains responded in approximately the same way without nitrogen as with nitrogen, but some striking exceptions to this occurred. For example, in the second clipping, strain 176 (22) ranked seventh without nitrogen but first with nitrogen while strain 129 (193) ranked third without nitrogen and 8th with nitrogen. Statistical analyses of the relationship between strain responses at the two fertility levels are in progress.

Comparative Behavior of Strains of *Poa pratensis* Alone and in Mixtures of Strains. The plots established in 1945 (1945 Annual Report, Page 41) were harvested for yield in 1948. The 6 replications were divided into 3 pairs and one replication of each pair was fertilized with nitrogen in the spring and following each clipping. The other replication of each pair was left without nitrogen fertilization. The plots receiving nitrogen fertilization were clipped 7 times during the summer while those receiving no nitrogen were clipped 5 times. Statistical analysis of these data is not yet complete, but preliminary results indicate that there was no striking advantage of mixtures of strains over pure strains. These results are consistent with those obtained in 1947 (1947 Annual Report, page 29). The yields of single strains and of composites of 2, 3, 4, and 5 strains at each clipping date are shown in Table 4.*** In the first 3 clippings there appears to be a general trend towards higher average yield of the composites than of the single strains. In no case, however, would the average yield of the composites equal the yield of the best single strain.

Production of Improved Strains of Bromegrass. Due to unfavorable weather conditions in the fall of 1947 the advanced polycross plot of 71 selected clones (1947 Annual Report, Page 29) failed to become well established. The stand was so unsatisfactory that this material will be reestablished in 1949.

*See Page 32

**See Page 33

***See Page 34

Isolation of Ladino Clover Plants Resistant to Sclerotinia Trifoliorum. Greenhouse tests of clones and seedlings of Ladino clover and of several white clover strains (1947 Annual Report, Page 31) are being continued. From replicated tests of clones it has been shown that significant differences exist in resistance to Sclerotinia although no clone has yet been isolated that is immune from the disease. Re-tests of survivors from the polycross progenies of selected clones and from strains and varieties of Ladino and white clover are not yet complete.

Genetic Investigations

Heritable Characters in Dactylis glomerata. In the spring of 1948, 97 F₂ progenies consisting of 20 to 100 plants in each progeny, were transplanted in the field. These F₂ progenies are from crosses involving parents with adult parent characters. No further work has yet been done with the studies of allelism of genes conditioning seedling characters (1947 Annual Report, page 31) although the original parental clones involved in these studies were established in the greenhouse in the fall of 1948. These clones will be self-pollinated and used in making further crosses.

Inheritance of Immunity from Crown Rust in Diploid Festuca elatior. From the F₁ seedlings obtained from crosses of immune, resistant and susceptible meadow fescue plants (1947 Annual Report, pages 31 and 32), 50 plants were selected and established in the greenhouse in the fall of 1948. These plants will be used for intercrossing and for crossing with the parental clones to produce F₂ and backcross seed.

Inheritance of Flower Color in Medicago sativa. In the fall of 1948, 79 plants with flower color varying from white to deep purple were established in the greenhouse. These plants will be used for crosses to study the inheritance of flower color differences.

Cytological Investigations

Origin of Aneuploidy in Dactylis glomerata. In continuation of the studies of chromosome numbers of plants from crosses between plants with 29 chromosomes, the number was determined for 405 plants. Of these one had 26, 15 had 27, 233 had 28, 123 had 29, 26 had 30, 4 had 31, and 3 had 42 chromosomes. The high incidence of 28 chromosome progeny plants and low proportion of plants with 30 chromosomes indicate a high frequency of loss of the extra chromosome in meiosis, drastic elimination of the gametes with extra chromosomes or both. The same parent plants used in the 32 progenies referred to above were involved in different crosses with 29 chromosome plants and seedlings from 35 such crosses have been grown in the greenhouse. Determination of chromosome numbers of these plants is in progress, but has not yet been completed.

Polycross Tests of Hexaploid Dactylis Glomerata. The hexaploid plants referred to in the 1947 Annual Report, Page 33, were intercrossed in the greenhouse and seedling progeny plants were established in the nursery in the spring of 1946. From the several hundred progeny plants, 24 were selected in the summer of 1947 and these were established in a polycross plot with 15 replications in the spring of 1948. This material will be used as a preliminary test of the practical usefulness of hexaploid orchard grass.

Studies on the Origin of *Dactylis glomerata*. The studies referred to in the 1947 Annual Report, pages 34 and 35, have been continued. Approximately 3,000 seedlings from F₂ progenies and from backcrosses to both parents of the cross of tetraploid *Dactylis aschersoniana* with orchard grass were established in the field in the spring of 1948. Also approximately 3,000 seedlings of F₂ and backcross generations of the cross of diploid *Dactylis aschersoniana* with the Iran diploid were established in the nursery. In continuation of the attempt to produce the tetraploid hybrid between *Dactylis aschersoniana* and the Iran diploid, further crosses between the colchicine induced tetraploids of these diploid types were attempted in the greenhouse in the winter of 1947-48. Not all of this material has yet been threshed, but preliminary results indicate that few, if any seeds were obtained due probably to the poor pollen production of *Dactylis aschersoniana* and to the almost complete male sterility of the tetraploid derived from the Iran diploid. As another approach to this problem, F₁ seed of two crosses of *Dactylis aschersoniana* x the Iran diploid was treated with colchicine. Among the resulting seedlings, a number were tetraploid or had mixtures of diploid and tetraploid tissue. The plants that appeared to be completely tetraploid were established in the greenhouse in the fall of 1948 and have been placed under lights to induce flowering. From the mixoploid seedlings, repeated vegetative propagations using single tillers have been carried out. By this procedure, a few pairs of diploid and tetraploid clones from the same original seedlings have been obtained. These similarly were established in the greenhouse and placed under lights to induce flowering. On the basis of results obtained to date with this material, it is expected that these tetraploid F₁ hybrids will represent *Dactylis glomerata*.

Selection in Diploid *Dactylis Aschersoniana*. Since the original material of *Dactylis aschersoniana* available at the Laboratory consisted only of three plants and is therefore of rather narrow gene base, attempts have been made to obtain additional material and to improve by selection the material already available. Two collections of seed of *Dactylis aschersoniana* were obtained from Mr. Gunnar Weibull. Although seed germination was very poor, as is characteristic of *Dactylis aschersoniana* generally, 65 seedlings were obtained from this seed and were established in the nursery in the spring of 1948. Open pollinated seed was harvested from 44 plants selected from the several hundred plants of *Dactylis aschersoniana* established in the field nursery in 1944. Two hundred fifty seedlings from this seed were planted in the nursery in the spring of 1948.

Chromosome numbers in collections of *Dactylis Glomerata*. In all of the plants of *Dactylis glomerata* collected in the United States only plants with 28 chromosomes or with aneuploid deviations from 28 have been obtained. With the discovery, however, of the diploid type of *Dactylis* from Iran and with the evidence from crosses of that diploid type with *Dactylis aschersoniana* which indicates that orchard grass may have arisen from such a diploid hybrid, it seemed desirable to determine chromosome numbers of as wide a range of European material as possible. Through the courtesy of Mr. J. R. Cowan, at that time of the Central Experiment Farm, Ottawa, Canada, it was possible to obtain seed of 82 collections from 11 European countries. In addition, from the Hebrew University in Palestine it was possible to obtain one seed collection from Israel. Chromosome numbers of approximately five plants of each of these sources have been determined. One plant from a collection

obtained from Finland had 42 chromosomes. The source of this seed was said to have been a cross of Dactylis aschersoniana x D. glomerata. Twenty-one plants of six collections from the University of Königsberg, Germany, had fourteen chromosomes. The morphological characteristics of these 14 chromosome plants have not yet been determined. These plants were established in the nursery in the spring of 1948 and will be available for morphological studies in 1949. The 19 plants of the seed collection from Israel all had 28 chromosomes and on the basis of vegetative characteristics resemble the Iran diploid. These plants are at present being grown in the greenhouse to induce flowering.

Interspecific Relationships in Bromus. As an approach to understanding the complex cytogenetic relationships in bromegrass, a study of interspecific hybridization in related species of the genus has been initiated. Seed of 31 species was obtained during the summer of 1948 and plants of each of these species are being grown in the greenhouse for use in crossing experiments.

Hybridization of Lolium Perenne by Festuca elatior. Attempts to produce the tetraploid hybrid between Lolium perenne and Festuca elatior (1947 Annual Report, Page 35) have been continued. Cross pollinations were made between diploid perennial rye grass and diploid meadow fescue and between colchicine induced tetraploid clones of these species. A few seeds were obtained and seedlings from these seeds are now being grown in the greenhouse to determine whether they are hybrids. The F₁ plants of crosses between these species obtained previously (1947 Annual Report, Page 35) were treated with colchicine and subsequently determinations of chromosome numbers were made. It was discovered that one of these plants had 21 chromosomes in untreated tissue. Judging from morphological characteristics it seems probable that the hybrid arose from union of an unreduced gamete from perennial ryegrass with a reduced gamete from meadow fescue. Each of the remaining five plants had 28 chromosomes in untreated tissue, suggesting that the fescue parent was hexaploid.

TABLE 1.

Analysis of variance and covariance of yields of dry matter of 15 clones of orchard grass spaced in plots and of their polycross progenies seeded broadcast. Check plots of commercial seed were space planted and broadcast in each replication.

Var. due to	Mean Square	F ⁽¹⁾	1st Aftermath Mean Square	F	2nd Aftermath Mean Square	F	Total Mean Square	F
Analysis of variance								
Clones	0.63	1.61	0.22	6.11	0.26	5.70	1.12	2.19
Clones X								
Planting	0.50	1.29	0.09	2.55	0.05	1.13	0.82	1.61
Error	0.39		0.04		0.05		0.51	
Analysis of covariance								
Diff. for testing								
Adj. Means	294.98	1.82	178.63	1.13	310.76	1.95	259.29	1.60
Error	162.21		157.39		159.36		161.63	

(1)

For comparing mean square for clones with mean square for error and mean square for clones X method of planting with mean square for error, F for P of 0.05 = 1.86 and for P of 0.01 = 2.39.

TABLE 2.

Mean squares and values of F for comparisons of total yield of herbage per plot of Kentucky bluegrass strains and interaction of strains X height of clipping with and without nitrogen fertilization at various dates of harvest in 1948

Var. due to	Clipping											
	First			Second			Third			Fourth		
	No	N		No	N		No	N		No	N	
(1) Strains	12,199	36,189	1,849	13,354	4,426	11,779	3,242	1,638	2,196	6,329	17,630	
Str. X Ht.	102	6,240	1,091	2,236	2,880	971	3,315	611	2,429	1,184	932	
Error	221	2,185	484	722	993	757	933	543	1,617	865	1,098	
(2) F Str Error	55.2	16.6	3.8	18.5	4.5	15.6	3.5	3.0	1.4	7.3	16.1	
(2) F SXH Error	0.5	2.9	2.3	3.1	2.9	1.3	3.6	1.1	1.5	1.4	0.8	

(1) Degrees of freedom for strains = 7, strains x height = 7, and error = 42

(2) F for P of 0.05 with 6 and 40 D/F = 2.34 and F for P of 0.01 = 3.29

Table 3.

Rank in total yield of herbage of eight strains of Kentucky bluegrass with and without nitrogen at several dates of harvest in 1948.

Clipping Number

	1			2			3			4			5			6		
	No	N	N	No	N	N	No	N	N	No	N	N	No	N	N	No	N	N
114(12)	3		3	6		4	8		4	8		8	8		8	8		5
129(193)	2		4	3		8	7		7	5		7	6		6	6		7
130(136)	4		2	1		2	6		3	7		2	5		3	3		3
139(111)	5		5	4		7	4		6	6		5	7		4	6		6
143(223)	1		1	2		3	5		1	4		4	4		1	4		4
170(3)	8		8	8		6	1		5	2		1	1		2	2		2
172(14)	6		6	5		5	3		8	3		6	3		7	8		8
176(22)	7		7	7		1	2		2	1		3	2		5	1		1

TABLE 4

Average yield in grams of totals of three replicates of five single strains, ten composites of two strains, ten composites of three strains, five composites of four strains, and one composite of five strains of Kentucky bluegrass, with and without nitrogen fertilizer at seven dates of harvest in 1948

	First		Second		Third		Fourth		Fifth		Sixth		Seventh		Total	
	N	No N	N	No N	N	No N	N	No N	N	No N	N	No N	N	No N	N	No N
Five single strains	534.8	406.2:	845.7	562.3:	520.2	301.0:	756.2:	387.7	520.5:	378.0	275.2:	539.7:	3962.3	2065.2		
Ten composites of two	582.5	444.7:	829.3	630.5:	523.7	319.0:	729.6:	403.3	547.1:	379.0	288.3:	567.0:	4014.4	2229.6		
Ten composites of three	617.1	481.6:	844.4	638.8:	522.4	325.5:	743.6:	386.9	568.6:	370.0	299.6:	561.9:	4046.3	2314.1		
Five composites of four	628.2	408.9:	859.8	598.6:	528.0	311.3:	731.2:	377.8	527.2:	361.6	254.8:	547.6:	4034.2	2100.8		
One composite of five	612.0	548.0:	816.0	625.0:	577.0	311.0:	739.0:	426.0	673.0:	395.0	324.0:	564.0:	4129.0	2481.0		

PATHOLOGY

Studies with Sclerotinia trifoliorum

Continuing the work on S. trifoliorum (1946 Annual Report, Page 34; 1947 Annual Report, Pages 36-39) several phases of the problem were investigated.

Pathogenicity of Monoascospore Isolates to Ladino and Red Clover. Since preliminary tests showed that cultures of S. trifoliorum obtained from sclerotia were pathogenic to seedlings and mature plants of Ladino clover, additional tests were conducted to determine the pathogenicity of monoascospore isolates. The frequent observation of anastomoses between hyphae indicates the possibility of the development of heterocaryotic mycelium. Sclerotia may, therefore be comprised of the mycelium of one or several biotypes and cultures derived from such sclerotia would not represent homozygous lines of the organism. With this in mind, 28 monoascospore cultures representing isolates from each of 13 apothecia were arbitrarily selected for pathogenicity trials. After each isolate was cultured on a wheat-oats medium, fresh inoculum from it was placed in contact with crowns of seedlings and older plants of Ladino clover and mature plants of red clover. In the tests with Ladino clover, 4 seedlings and six mature plants were inoculated with each isolate of Sclerotinia. In the trial with red clover, 12 mature plants were inoculated with each isolate. The inoculated plants were thoroughly watered, placed at random and incubated in a greenhouse bench moist chamber (1947 Annual Report, Page 39). Most of the monoascospore isolates from Ladino or red clover proved to be equally pathogenic to each host. With few exceptions, seedlings of Ladino clover were more susceptible than older plants. Though there were some differences in virulence among isolates the differences were probably masked because of variation in resistance among plants of each host tested. Similarly, it was not possible to distinguish slight variations in pathogenicity among monoascospore cultures from individual apothecia.

A larger number of plants was inoculated with several isolates in a second test. The plants were grown in 3-inch pots in a greenhouse and the stolons were clipped when they reached the edge of the pot. For the test, 4 monoascospore isolates were selected, a pathogenic isolate from Ladino clover and one from red clover and a less virulent isolate from each host. The plants were inoculated by scattering freshly prepared inoculum over the stolons. From the classification of inoculated plants shown in Table 1*, it is evident that there were striking differences in pathogenicity among the selected isolates. Though there undoubtedly were differences in susceptibility among plants within an inoculation group, the overall damage caused by virulent isolates was greater than that by the less virulent ones.

Effect of S. trifoliorum on species of Trifolium, Medicago, Melilotus and Lotus. S. trifoliorum has been reported to attack more than 80 species in 15 families. Since Trifolium repens was listed as a species ordinarily resisting infection, it seemed desirable to test pathogenicity of isolates from this host to other species of forage legumes. For the test, 3 pots of seedlings 6 to 10 weeks old and 4 or 5 mature plants of each species in bud or flowering were inoculated. Inoculum consisted of a composite sample of 7 pathogenic monoascospore cultures grown on the wheat-oats

*See Page 37

medium. Most species tested were susceptible to the inoculum used, including several species of Trifolium, Medicago and Melilotus not previously tested. Of 19 species of Trifolium tested at the Laboratory, at least 3 species, T. resupinatum, T. fragiferum and T. dubium were not damaged as severely as the others. T. dubium, in particular, appeared moderately resistant to infection with the cultures used. None of the 6 species of Medicago, 4 species of Melilotus, or 1 species of Lotus tested showed resistance to attack. There was no appreciable difference between seedling and mature plant reaction.

Degeneration in Sclerotinia trifoliorum. When some monoascospore isolates of S. trifoliorum are grown for long periods with infrequent transfers on Potato-dextrose agar they tend to "degenerate." This "degeneration" is manifested by slower growth with production of few or no sclerotia. In severe cases, the cultures fail to grow at all and may be lost. It was suggested by others that "degeneration" can be prevented by frequent transfers to fresh media or that "degenerate" cultures may be revived by rapid serial transfers on fresh culture media.

The effect of rapid subtransfers to fresh culture media was tried on 10 monoascospore isolates that showed positive signs of "degeneration." For comparison, fresh, rapidly-growing counterparts of each isolate were obtained from sclerotia harvested from the original 1946 increase of each monoascospore isolate and stored dry at 5° C. since then. The "fresh" and "degenerate" counterparts of each of the 10 isolates selected for the test were then grown in duplicate in Petri dishes of potato dextrose agar at 15° C. At this temperature, "fresh" cultures usually grew the full diameter of a Petri dish (90 mm) in five days. The "degenerate" cultures grew only about 1/2 the diameter of the Petri dish during the same period. A sub-transfer usually consisting of an 8 mm. disk of inoculum made from each Petri dish to a fresh dish of potato dextrose agar every 5 days.

After more than 20 serial passages, most of the "degenerate" isolates still had not been restored to the same rate of growth as their "fresh" counterparts. Three of the ten "degenerate" cultures were restored to the same rate of growth and sclerotia production as their "fresh" counterparts after 3 or 4 subtransfers. The remainder were not restored to normal growth by rapid subtransfer nor did they regain their ability to produce sclerotia.

In order to test the possibility that rate of growth might be affected by temperature, the 7 isolates that showed differences in rate of growth between "fresh" and "degenerate" types were transferred in duplicate to Petri dishes of potato dextrose agar. One set of "fresh" and "degenerate" cultures from each isolate was then incubated at the following temperatures 5°, 10°, 15°, 20°, and 28°C. Measurements showed that the spread in relative growth rates was maintained at temperatures below 15°C but that at 20° and 28° C the rates of growth of the two types of cultures were similar. Although not so pronounced, there appeared to be a similar effect on cultures grown at 5° C. Above 15° C and at 5° C cultures grew more slowly than normal. The effect probably was due to slowing-down of the rapidly growing "fresh" type rather than a speeding-up of the slow-growing "degenerate" type. This may indicate greater response to adverse conditions in the rapidly growing cultures. Additional tests are underway to determine whether different kinds of culture media influence rate of growth.

Susceptibility of some species of Trifolium, Medicago, and Melilotus to Erysiphe polygoni. During the winter of 1947-48, a number of species of forage legumes growing in a greenhouse became infected with powdery mildew, Erysiphe polygoni D. C. The heavy infection with mildew of red clover plants growing in the same house suggested that the race or races of E. polygoni parasitizing red clover infected the other hosts. Outside contamination seemed unlikely since seed of each species, except T. pratense, L. was planted in October and infection was observed only on older plants in midwinter. There was considerable variation in susceptibility among plants of each species which was represented by at least 10 and in most cases by 30 plants. Production of conidia on leaves was used as a criterion for determining infection. No artificial cross-inoculations were made.

Heavy infection was obtained on Trifolium dubium and T. procumbens both of which resisted infection in tests of other workers. Conversely, other workers have reported T. fragiferum susceptible to powdery mildew from red clover. In the present observation 30 plants of this species grew adjacent to heavily mildewed plants of T. dubium and T. pratense for several months without becoming infected. In addition, 2 out of 6 species of Medicago and 1 out of 4 species of Melilotus became infected with powdery mildew.

The variability in results indicates several factors may be operating: (a) There may be geographic distribution of physiologic races of the organism, (b) Environmental conditions where observations were made may have conditioned infection on some hosts. Although cross inoculation tests would have eliminated doubt, it seems reasonably certain that infection on the different host species spread from infected red clover. Variance from previously published data may suggest the presence of possibly one or more additional physiologic races.

Table 1
Comparative virulence of four isolates of Sclerotinia trifoliorum to mature plants of Ladino clover

Infection Class	Number of plants in each infection class after inoculation with isolate					Control
	R-1-4	L-6-8	R-3-8	L-1-10		
Slight	5	9	41	23		0
Slight+	0	1	14	16		0
Moderate	12	8	14	15		0
Moderate+	11	14	2	4		0
Severe	24	21	1	2		0
Severe+	17	10	0	0		0
Dead	3	1	0	0		0
No Injury	0	0	0	0		18
Totals	72	64	72	60		18

PHYSIOLOGY AND COMPOSITION OF PASTURE PLANTS

Effects of Isopropyl N-phenyl Carbamate on
Inhibiting Head Formations of Orchard Grass

Work conducted by the U. S. Army Chemical Corps at Camp Detrick, Maryland has shown that isopropyl N-phenyl carbamate inhibits reproduction in some of the small grains species. It was thought that possibly this growth regulating chemical might also reduce or inhibit the number of flowering stalks produced by orchard grass in the spring of the year. Inasmuch as the flowering stems of orchard grass are relatively unpalatable to cattle, they often become a problem on many pastures which may not be grazed early enough in the spring or are understocked. With this in mind, preliminary studies on the application of various amount of INPC to orchard grass were begun, both in the field and in the greenhouse.

Field Trials

The orchard grass available for use in the field was an association with Ladino clover, from which the clover had disappeared. The area was laid out into 4-foot x 4-foot plots on which INPC could be applied on 9 dates and at 5 rates plus a no-treatment "check." These rates included 1/2, 1, 2, 4, and 8 pounds per acre of INPC. The INPC was applied to one replication in the powder form diluted with soil and to two replications dissolved in water and sprinkled on with a watering can. Fall applications were made on three dates: September 19, October 20, and November 13. Spring applications were made March 24, April 1, April 8, April 16, April 26, and May 6. On the date of the first application in the spring, head primordia were not apparent by micro-dissection of the growing point. At later dates of application the growing points were from early to late stages in development of the reproductive primordia.

Fall applications of the INPC had no pronounced effect on the production of heads the following spring. Spring applications, however, had marked effects. The March application appeared to be most injurious to the plants and the May applications had the least specific effect on reducing head formation. On June 13 all plots were cut and the herbage from four of the dates (March 23, April 8, April 16, and April 26) was taken into the Laboratory where the number, height, and dry weight of the heads and the dry weight of the total amount of leaf growth were determined (Table I).

Inspection of these data indicates that an application of one or two pounds of INPC per acre greatly reduces the number of flowering stems formed and increases the weight as well as the proportion of leaf tissue produced. The higher rates of application reduced both head and leaf formation so that its use would probably be impractical. The one-half pound rate reduced the number of flowering stems only slightly.

Relative to the time of application, the data (not shown) indicated that the April 8 dates reduced head formation by the largest amount and also produced the largest weight of leaves.

Greenhouse Trials

Orchard grass plants grown in gravel culture were given various amounts of isopropyl N-phenyl carbamate in the nutrient solution. The object of these trials was to determine the effects on heading of various concentrations of INPC for various lengths of time.

Tillers of a clone of orchard grass known to head well under greenhouse conditions were planted in gallon crocks of coarse gravel on December 15 and supplied with a balanced nutrient solution (1938 Annual Report, Page 51). Three tillers were started in each crock and were allowed to grow under the normal winter day length of about 9 to 10 hours for 2-1/2 months. On January 23 supplementary light was supplied to provide a 16-hour day and initiate heading. Samples of the tillers were taken up at several intervals for micro-dissection to determine when reproductive primordia were first evident. These were found 5 days after the lights were turned on and the first INPC treatments were then started. Eleven days after the lights were turned on, when secondary protuberances were evident on the primordia, the second INPC treatments were begun.

The treatments with INPC consisted of replacing the balanced nutrient solution with similar solutions containing 4 concentrations of INPC, namely 0.4, 0.8, 1.6, and 3.2 p.p.m. These were given to triplicate pots for periods of 3 hours, 6 hours, 12 hours, and 24 hours after which the gravel was well rinsed with tap water and the balanced nutrient solution replaced. In addition to the INPC applied for short intervals, 4 concentrations were supplied continuously in the nutrient solution, namely 0.1, 0.2, 0.4, and 0.8 p.p.m. The short-interval and continuous INPC treatments were started at the two dates when the lights were turned on.

On all pots of each treatment the heading and flowering dates were recorded. Similarly, data were taken on the height of the center head of each plant and the weights of reproductive stems and tillers and vegetative tillers and leaves. The total number of heads per pot was not significantly reduced by any of the treatments used except at the highest concentration in the continuous series. There was however, a delay of several days to a week or longer in the heading and flowering dates of plants receiving the higher concentrations of INPC. There was a progressive decrease in the height of the flowering stems with increasing concentration and/or longer exposure to the INPC. Corresponding to this, there was in most cases a decrease in the dry weights of reproductive tillers and attached leaves and a slight increase in the weights of the vegetative parts. There was no serious decrease in the total dry weights per pot except in those subjected to 0.8 p.p.m. continuously. In the series using various concentrations of INPC for different intervals, 1.6 p.p.m. for 24 hours or 3.2 p.p.m. for 12 hours or 24 hours appeared to be most effective in reducing size of heads without reducing appreciably the total dry weight. Continuous application of INPC at 0.4 pounds p.p.m. offered greatest practical use. The 0.8 p.p.m. concentration seriously reduced total growth. It was evident from all treatments that INPC was most effective in reducing heading when it was supplied early in the initiation of the inflorescences.

Effects of rate of application of isopropyl N-phenyl carbamate (INPC) in solution on inhibition of flowering stem formation in Orchard Grass. (Average of four spring dates of application).

Pounds INPC applied per Acre	Height of flowering stems	Number of flowering stems	Weight of flowering stems/plot	Weight of leaves /plot	Total weight /plot	Flowering stems by weight
	cm		gm	gm	gm	%
0	79	214	202	85	287	71
1/2	81	291	195	87	281	69
1	80	170	119	123	242	47
2	77	72	54	137	191	28
4	72	14	11	100	114	10
8	65	4	4	54	57	10

The Responses of Dactylis glomerata-Trifolium Repens to Nitrogen Fertilization, Soil Moisture, and Clipping Treatments.

Studies of the effects of nitrogen fertilization, irrigation, and clipping treatments on yields of orchard grass and of Ladino clover in a grass-clover association were determined (1947 Annual Report, Page 42). In these experiments the high nitrogen plots received nitrogen fertilizer following each clipping in an attempt to insure adequate nitrogen for maximum yields. The total nitrogen applied ranged from 200 to 300 pounds, per acre. The highest rate was, of course, applied to the irrigated plots. All plots received phosphate and potash.

There was very little clover on any of the plots in the fall of last year and early spring of this year. On plots that received no nitrogen, whether clipped frequently or cut for hay, Ladino clover increased markedly during the summer but except on the irrigated series the soil was so dry that growth was very poor. The high nitrogen plots were practically pure orchard grass.

The yields of dry matter this year ranged from 2339 to 9515 pounds per acre (Table A.), as compared with 3148 to 8911 pounds last year. In both years the highest yields were obtained from plots that received nitrogen fertilization and irrigation and were cut for hay, whereas the lowest yields were from plots that received no nitrogen or irrigation and were clipped to simulate rotation grazing. In the latter case the particularly low yield this year is attributed to a deficiency of available nitrogen in the spring followed by dry weather during the summer and fall.

In general, the increases in yield were about 2000 pounds of dry matter from irrigation and about 4000 pounds from high nitrogen.

Table A. Yields of dry matter in an orchard grass - Ladino clover sod as affected by nitrogen fertilization, soil moisture, and clipping treatment.

Clipped to simulate	Dry Matter, Lbs. per Acre			
	Not Irrigated		Irrigated	
	No N	High N	No N	High N
Rotation				
Grazing	2339	5962	4487	8045
Hay and				
Aftermath	3212	7648	5380	9515

Reserve Studies on Grasses

Chemical analyses of orchard grass collected in two greenhouse experiments have been completed. Previously reported have been yields (1944 Annual Report, Pages 51-54), and nitrogen and sugar contents (1945 Annual Report, Pages 62-63; 1947 Annual Report, Pages 45-46).

In an aftermath experiment under two levels of nitrogen fertility in which tops were clipped every 35 days, cycles of fructosan concentration occurred between periods of clipping. Immediately following the clipping of the tops the fructosan percentages of the stubble and roots dropped rapidly to reach a low point 1 to 3 weeks later and then rose to reach a maximum at the time of the next clipping, 35 days after the previous one. A plotting of the fructosan contents of the stubble and roots against time gave a U-shaped curve such as has been noted previously with ryegrass. The fructosan content of the stubble was considerably higher than that of the roots of the same plants and in both plant parts it was considerably higher in the low nitrogen plants than in those under high nitrogen nutrition.

This aftermath experiment may be briefly summarized as follows: Following each clipping the stubble and roots underwent losses in sucrose, total sugars, and fructosan and increases in total nitrogen and soluble nitrogen as percentages of the dry weight and also increases in soluble nitrogen as percentage of total nitrogen. After a period, varying from a few days to several weeks, these trends were reversed and the composition of the stubble and roots approached that which they had at the time of clipping. Plants under a high level of nitrogen nutrition were higher in weight of new top growth and of total plant, in general higher in weight of stubble but lower in weight of roots, higher in percentages of total and soluble nitrogen and reducing sugars and lower in percentages of sucrose and fructosan than those plants which received less nitrogen.

In a hay and aftermath experiment in which fertilizer was applied at different times in relation to the date of cutting for hay the fructosan contents of stubble and roots paralleled those of sucrose but were usually higher in quantity. The series of plants which received no nitrogen fertilizer was almost without exception higher than any other series in fructosan. When nitrogen was applied to other plants the fructosan content

decreased sharply and was significantly lower than in the low nitrogen series at the sampling date following the application, whether before or after the cutting for hay. The fructosan content of the stubble of all series rose significantly during the last week of the experimental period and at the end, 35 days after hay cutting, the percentages of fructosan were in general related inversely to the time elapsed since the application of nitrogen.

Some conclusions which may be drawn from this experiment are as follows: The maximum yields of hay and stubble and the highest protein content were obtained from the series which had been the earliest to receive nitrogen fertilizer, 14 days before cutting. The highest yields of the 35 day old aftermath and of stubble at the same date were obtained in those plants fertilized the day on which the hay was cut but the highest protein percentages of both tops and stubble were in the series that was the last to receive nitrogen, namely, at 14 days after hay cutting. Both cutting the grass and the addition of nitrogen fertilizer had the same effect in causing a temporary increase in the percentage of total and especially of soluble nitrogen in both stubble and roots and a temporary decrease in soluble carbohydrates. Soluble carbohydrates, therefore, were highest in the plants receiving no nitrogen or receiving it at the earliest dates.

Hydrocyanic acid content of Trifolium species.

The prevalence of hydrocyanic acid in Ladino clover was determined by making qualitative tests by the picric acid method. It was found to occur less frequently in Ladino than in common white clover (1938 Annual Report, Page 58). Of 635 clones of Ladino clover involved in the breeding program and growing in soil in the greenhouse only 13 gave a positive test for HCN. On a scale of 1 to 4, one read 1, two read 2, one read 3, and nine were in the highest range of concentration of HCN with a reading of 4. Of 400 seedlings from commercial seed growing in gravel culture and tested by the mass method, 12 gave a positive test.

Also tested by the mass method and all found negative in respect to presence of HCN were the following Trifolium species, followed by the number of clones tested:

<u>T. dubium</u>	21	<u>T. arvense</u>	9	<u>T. fragiferum</u>	21
<u>T. subterraneum</u>	1	<u>T. lappaceum</u>	7	<u>T. resupinatum</u>	21
<u>T. agrarium</u>	21	<u>T. hybridum</u>	36	<u>T. procumbens</u>	20
<u>T. alexandrinum</u>	10	<u>T. cernuum</u>	6	<u>T. incarnatum</u>	6
<u>T. glomeratum</u>	22	<u>T. hirtum</u>	20	<u>T. reflexum</u>	5
<u>T. striatum</u>	7	<u>T. pratense</u>	100		

and also the Grimm variety of Medicago sativa, 33.

The mass method of testing was to combine into one test single leaves from 20-25 plants. If negative, all plants included were classed as negative. If positive they were tested again, either individually or in smaller combinations.

Winter Killing of Ladino Clover

The two areas seeded in August 1945 to study the effects of fall clipping treatments and winter ground cover (1947 Annual Report, Pages 46-47) on the winter survival of Ladino clover were discontinued in 1948. Nearly all the Ladino had disappeared by spring regardless of the fall clipping treatment or winter cover provided. No yields were taken on the remaining stand of orchard grass. It was observed that those plots receiving three fall defoliation treatments produced fewer and smaller heads of orchard grass than those getting no fall clipping.

In April 1947 a new area was seeded to Ladino clover in pure stand and in combination with orchard grass. Good initial stands of both species were obtained. Differential fall clipping treatments and mulch applications were used. These included duplicate plots cut on (1) Sept. 15 only, (2) Sept. 30 only, (3) Sept. 15, and October. 15, (4) Sept. 15, October 15, and Nov. 15, (5) Sept. 15, Sept. 30, Oct. 15, and Nov. 15, and (6) Nov. 15 only. The mulch treatment comparisons were (1) No mulch, (2) Wheat straw mulch applied early in December to be removed in February and (3) Mulch to be removed in April.

The prevailing soil surface conditions during the winter of '47-'48 were variable. A snow cover was lacking in December while in January and February there was good snow protection. The plots from which the mulch was removed in April showed the best Ladino stands; those where mulch was taken off in February showed some winter injury while the "no mulch" treatment resulted in appreciable injury.

Yields of the orchard grass Ladino plots were taken on May 26, 1948. Those plots having had four fall clippings gave the lowest yield, 2011 pounds of dry matter per acre. Plots cut only the previous September or November produced the highest yields, 2500 pounds. The November clipping reduced the stand of Ladino clover perhaps due to removal of cover. Frequent fall clippings did not appear to retard the spring recovery of the clover. Measurements taken on the height of the orchard grass culms indicated that fewer and shorter culms resulted from the more frequent fall clippings.

Recovery of Ladino Clover Stolons Following Desiccation

Desiccation and subsequent recovery tests were conducted on two groups of stolons taken from Ladino clover growing in the greenhouse and in outdoor plots. The stolons were divided into uniform lots, placed in a laboratory type desiccator over calcium chloride and in a coldroom, at 1° C. At intervals of 2, 4, 6, and 8 days, dry matter determinations on a part of each lot were made and the remaining portion was allowed to recover on moist toweling in a covered glass dish. Results and observations are presented in Table B.

Table B. Effect of desiccation on the recovery of Ladino clover stolons.

Days in Desiccato	%Dry Matter Material From		Recovery* following desiccation	
	Field	Greenhouse	Field	Greenhouse
--	26.2	23.0	1	1
2	35.1	29.4	1	2
4	54.3	42.3	3	2
6	57.4	56.9	4	4
8	75.9	65.1	Stolons dead	Stolons dead

* 1 = Excellent,

5 = Very poor

The clover stolons still made a fair recovery from desiccation when their dry matter content had been increased to 50%. Beyond this point the cuttings had difficulty in regaining turgidity even under the favorable conditions of this trial.

PART III

PASTURE RESEARCH AT STATE STATIONS

STORRS (CONNECTICUT) AGRICULTURAL EXPERIMENT STATION

Title: Grassland Renovation Trials in Connecticut

Leaders: For Storrs Agricultural Experiment Station - B.A. Brown and R. I. Munsell; for Pasture Research Laboratory - V.G. Sprague

Results: In June, 1948 the grazed pasture disked in the fall of 1942 and seeded to Ladino in the spring of 1943, had only 1.3 percent of the area occupied by Ladino, while 20.8 percent had native white clover. The chief grass was Kentucky bluegrass, which recovered very rapidly after the initial disking. The yield as measured by grazing with yearling Holstein heifers ranked sixth among seventeen pastures, being surpassed by two which received spring nitrogen, one that received poultry manure at two tons, and two LPK pastures.

The six-year average production of this renovated pasture is not much different from similarly fertilized ones without either tillage or seeding. This unsatisfactory result is due to the failure to secure a good stand of Ladino and that failure traces to the extremely dry summer of 1943.

The grazed pasture seeded with birdsfoot trefoil, without tillage, in the spring of 1943, had 1.3 percent of its area occupied by trefoil in June 1948. It appears that the trefoil does not spread much on closely grazed pastures. This pasture had 13 percent native white clover and ranked thirteenth among seventeen in yield.

MAINE AGRICULTURAL EXPERIMENT STATION

Title: Evaluation of Forage Plants-Clones, Lines, Varieties and Hybrids Developed by Plant Breeding

Leaders: C. H. Moran, W. C. Libby

The objectives of this new project are 1. to investigate for Maine conditions the adaptability of forage plant varieties and hybrids and 2. to determine their total yield, seasonal distribution and persistence under various systems of management. The nursery for the evaluation of the plant material will be located at Orono. First plantings will be made in the spring of 1949.

Title: Management Practices as They Affect The Productivity and Persistence of Ladino Clover-Grass Associations

Leaders: C. H. Moran, H. Dickey, W. C. Libby

The objectives of this study were originally reported in the 1944 Annual Report of the Laboratory. Land requirements for veteran

housing made a change of location necessary. The project was revised and relocated in 1948 on a new farm at Stillwater, Maine.

Duplicate areas have been seeded to associations of:

1. Brome grass - Ladino clover
2. Timothy - Ladino clover
3. Reed Canary - Ladino clover

Two management systems will be used for the present:

1. Cut at early hay-silage stage and graze aftermath
2. Rotationally graze all season

Title: The Carotene, Thiamine, and Riboflavin Content of Some Grasses and Clovers Grown in Maine.

Leader: B. E. Plummer, Jr.

A study of the chemical composition of grasses and legumes commonly grown in Maine for forage has been conducted for several years. During the past year this study has been confined to carotene, thiamine, and riboflavin analyses. Samples were taken at different stages of growth during June, July, and the first part of August. Carotene determinations were made on the fresh material. Samples were artificially dried and carotene, thiamine, and riboflavin determinations were made on these samples.

The legumes ran higher than the grasses in each of the three vitamins. There was also a decrease in the vitamin content as the plants became more mature with a rapid drop during the last stages of maturity. Timothy cut June 20th contained 3.1 ppm thiamine, 9.4 ppm riboflavin, and 145 ppm carotene, while timothy cut August 4th contained 1.9 ppm thiamine, 4.8 ppm riboflavin and 41 ppm carotene. Alsike clover cut June 23d contained 5.5 ppm thiamine, 20.0 ppm riboflavin, and 276 ppm carotene and on August 7th it contained only 1.8 ppm thiamine, 9.3 ppm riboflavin, and 32 ppm carotene. The other crops studied had similar trends.

MARYLAND AGRICULTURAL EXPERIMENT STATION

Title: Pasture Renovation Studies

Leaders: A. O. Kuhn and T. S. Ronningen

Renovation studies are being conducted to compare various seeding mixtures and disking vs. shallow plowing for seedbed preparation. Duplicate seedings of eight mixtures (1947 Annual Report, Page 50) during March of 1947 produced stands in 1948 in which the originally seeded species comprised the following percentages of the total vegetation:

<u>Treatment</u>	<u>June 30</u> <u>(Point Quadrat)</u>	<u>July 22</u> <u>(Estimated)</u>
Plowed	68.9%	72.0%
Disked	38.2%	31.2%

Under both disking and plowing, orchard grass in combination with legumes results in better stands than were obtained from timothy, Lincoln brome grass, or Kentucky 31 fescue. Original establishment of Ladino clover was so poor that it failed to become an important part of the mixtures during 1948. Broadleaf birdsfoot trefoil stands compared favorably with Kenland red clover and Atlantic alfalfa.

Title: Orchard Grass and Brome grass For Forage With Legumes

Leaders: A. O. Kuhn and T. S. Ronningen.

First harvest year clipping yields from triplicate plots of 0.7 acre each of orchard grass in mixture with alfalfa, red clover and Ladino clover as compared to Lincoln brome grass with these same legumes were 6400 pounds of dry matter per acre for the orchard grass plots and 6500 pounds of dry matter per acre for the brome grass. Yields were based on the difference between grazed and ungrazed caged areas.

Title: Alfalfa Variety Test

Leaders: A. O. Kuhn and T. S. Ronningen

First year harvest results from pure stands of alfalfa at four locations in the Piedmont area of Maryland were as follows:

<u>Variety or Source</u>	<u>Yield in Tons per</u> <u>Acre Dry Matter</u>
Atlantic	3.20
*Argentine	3.11
Buffalo	2.93
Kansas Common	2.87
Williamsburg	2.86
Grimm	2.83
Ranger	2.73
Least Significant Difference .05	0.275

*From South of Bahia Blanca

Title: Red Clover Management To Maintain Stands

Leaders: A. O. Kuhn and R. J. Allen, Jr.

During the past three years, dying of red clover during the fall of the seedling year or early spring of the hay year has caused the loss of many stands in Maryland which were initially good. During 1948 an experiment was set up involving 16 variations in management of stands following combining of small grain. This experiment is being conducted at four locations in the state, with five replicates at each location.

During October stand counts were made of surviving red clover plants to see what effect these treatments had on the number of plants per

square foot. The average of all locations showed that the best treatment, consisting of immediate removal of straw followed by cutting the clover at one-half bloom stage and removing the hay, followed by clipping the clover in early September, gave an average of 13.5 plants per square foot. The poorest treatment, which consisted of no removal of straw or clipping, resulted in an average of 6.9 plants per square foot.

The counts are being continued during the winter of 1948-49 and a study is being made of root reserves under the various treatments as related to disease incidence. It is planned that this project will run for three years.

Title: Red Clover Breeding

Leaders: A. O. Kuhn and C. H. Liden

Many red clover varieties and strains used in the variety tests have failed due to the presence of diseases. It was planned to initiate a project to develop red clover that will be more resistant to the diseases causing these observed failures. Not only have stands in the tests been poor the second year, but also, as a general rule, stands in commercial plantings have become progressively less productive.

Work on the project was started in July, 1948, and is to continue for five-year periods.

During the late summer and fall, a survey was made to determine which pathogens were causing the most injury. Isolates have been made, and it is found that Fusarium spp. are present in most diseased root tissue. Colletotricum trifolii, the organism responsible for southern anthracnose, caused considerable damage this last season as in most years before. Losses from Sclerotinia trifoliorum, the crown rot organism, have been very heavy in many areas.

Seed lots from strains of red clover grown in the same area of Maryland for at least 12 years have been collected. To date, 14 lots collected are being used in inoculation screen tests conducted in the greenhouse. Inoculations are in progress with Fusarium spp., Colletotricum trifolii, and Sclerotinia trifoliorum. Surviving plants from these greenhouse screening tests and field tests will be used for basic breeding stock.

Representative seed lots from other states of the southern red clover region have been supplied by the U.S.D.A. Part of the survey work has been in cooperation with the U.S.D.A., Bureau of Plant Industry.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION

Title: Alfalfa Variety Tests

Leaders: G. H. Ahlgren and Alex Dotzenko

The tests in which the leading alfalfa varieties are compared have been underway at New Brunswick for many years. Relatively new additions are Atlantic, Ranger and Buffalo. The tests are replicated and stands are maintained for at least 3 or 4 years prior to beginning new plots.

The Atlantic variety has been superior to all others from the yield standpoint, followed by Buffalo and certain other commercial varieties. Actually, in the first two years of variety trial little difference is found between Atlantic, Buffalo and such varieties as Kansas Common and Hardigan. It is in the third or fourth year that pronounced differences show up. While the Ranger variety is persistent, it seems to be very susceptible to certain of the leaf spot diseases.

Title: Red Clover Variety Tests

Leaders: G. H. Ahlgren and Alex Dotzenko

Variety tests of this species have been underway for many years at this Station. The relatively new variety, Kenland, has performed in superior fashion for the last 3 years, is resistant to certain of the diseases and produces an exceptionally good yield at the second cutting. This latter point is particularly significant since normally better hay is made from the second cutting than is possible from the first.

Tests of this nature are also conducted on replicated plots. In recent years considerable difficulty in conducting red clover variety tests has been experienced due to the presence of Sclerotinia (crown rot). Our observations would indicate that Kenland is at least partially resistant to this disease.

Title: Brome Grass Strains

Leaders: G. H. Ahlgren and Alex Dotzenko

Approximately 20 strains of brome grass collected from various parts of the United States and Canada are under test. In general, these seem to fall into Northern and Southern types, and considerable variability between and among the strains has been found. Yield data, maturity, disease susceptibility and other items are being gathered from this test as it goes along. The Southern types appear to be approximately 20 per cent more productive than do the Northern types.

Title: Alfalfa-Brome Grass Management

Leaders: Alex Dotzenko and G. H. Ahlgren

Efforts are being made to determine the best method of maintaining a balanced stand of alfalfa mixed with brome grass. The first steps in undertaking this study have been to establish a series of cutting treatments beginning at 5 inches, then 10 inches, one-tenth bloom, one-half bloom, full bloom and seed setting stages. Early information indicates that clipping at the young stages reduces both alfalfa and brome grass and permits the ready influx of weeds.

Data on carbohydrate reserves, protein and mineral content of the alfalfa-brome grass under the various cutting treatments are being secured.

Title: Alfalfa Variety-Fertility Interactions

Leaders: G. H. Ahlgren, E. R. Purvis and A. Dotzenko

Four alfalfa varieties planted in replicated plots consist of Atlantic, Ranger, Buffalo and Kansas Common. The 12 fertility treatments have been applied to each variety ranging from low in nitrogen, phosphorus and potash to treatments in which an abundance of these materials has been added. Considerable difference is noted already in response of varieties to these fertility treatments although the test is only one year old. The minor element, boron, is also being considered.

Title: Roughage Survey

Leaders: C. S. Garrison and G. H. Ahlgren

An extensive survey of the type of hay made in New Jersey is underway. Samples collected periodically during the winter months from hay mows and other storage facilities, are brought to New Brunswick and graded. It is expected that some 800 to 1000 samples will be handled in this fashion during the present winter season.

The cooperation of various county agents in New Jersey has been excellent in conducting this study, as has the assistance of Mr. W. H. Hosterman of the Grain Branch Division, Production and Marketing Administration, U.S. Department of Agriculture.

Title: Breeding New Winter-Hardy, Disease Resistant and Productive Varieties of Red and Alsike Clover

Leaders: W. R. Battle and G. H. Ahlgren

Red clover. About 450 seedling red clover plants of the Kenland variety were established in the field. Seed of 11 additional red clover varieties is on hand, and will be used to extend the breeding nurseries. These will serve as the nucleus of a breeding program for the improvement of red clover.

Preliminary studies in the attempt to develop a technique for laboratory culture of red clover seeds have been completed. It appears that a satisfactory technique has been devised. Stems from 29 different plants cultured in 2% sucrose solution yielded an average of 51.7% seed set. The seeds appeared superior in quality to field-grown seed, and gave excellent germination. Among the more obvious advantages of this method of seed production may be mentioned freedom from insect, disease and weather injury with consequent loss of seeds. Also the ability to make crosses indoors under laboratory conditions tends toward greater accuracy and less strain for the plant breeder.

Alsike clover. Two thousand seedling alsike clover plants representing 20 United States, Canadian, and European strains were established in the field. Selections from these plants will be used in the attempt to develop a superior variety. So far there appears to be little difference between strains, but variation between plants within strains is great. The common opinion has been that alsike clover is not seriously troubled by disease. The spaced plants in this nursery were found this fall to be heavily infested with mildew, rust, blackstem, virus mosaic, and an unidentified crown or root rot. Statistical analysis indicates no significant differences between strains, all being heavily infested. Determination of correlation coefficients showed that the occurrence of blackstem is positively correlated with the occurrence of mosaic, and rust is positively correlated with mildew.

Title: The Utilization of Pastures in the Production of Pork

Leaders: For the New Jersey Agricultural Experiment Station
M. A. Sprague and George W. Van der Noot.

A trial was conducted during the summer of 1918 to determine the value of alfalfa, brome grass, rape and soybeans as part of the diet of swine, supplemented with approximately 1 1/4 pounds of concentrates for each 100 pounds of live weight. Three lots of 20 pigs, averaging 41 pounds each, were fed a ration of corn and meat scraps and were maintained on 2 half acres of alfalfa, alfalfa for 35 days and then rape; brome grass for 35 days and then soybeans. Eight additional pigs were full fed the above ration in the dry lot while eight others received a balanced ration. The average daily gain per pig on alfalfa, alfalfa then rape and brome grass and then soybeans was 0.34, 0.41 and 0.42 pounds respectively. The pounds of feed to produce one pound of gain were 1.74, 1.53 and 1.78. The pigs in dry lot fed the pasture ration required 10.87 pounds of feed for each pound of gain; the pigs fed a balanced ration required 2.99 pounds of feed for each pound of gain in weight while gains in these two lots were 0.83 and 1.19 pounds per pig per day respectively. The cost (based on retail feed prices) of each pound of

gain for the pigs on alfalfa was 8.7%; alfalfa then rape 7.6%; brome grass then soybeans 8.9%; and for those pigs fed a balanced ration in dry lot it was 14.9% compared to 5.1% for the pigs fed the pasture ration in dry lots.

Data collected on the 300 pigs grazed on the three pasture mixtures at Bordentown have not been summarized to date. Separate lots of pigs were maintained on 2 feed levels (1 and 2 pounds concentrate feed per day per hundred pounds of live weight) on each of the three mixtures alfalfa, alfalfa brome grass and Ladino brome grass. The lower rate of feeding was insufficient necessitating raising that group to 2 1/4 pounds.

Title: All Roughage and Pasture Feeding Experiments with Dairy Cattle.

Leaders: For the New Jersey Agricultural Experiment Station - M.A. Sprague and C. B. Bender

A study is underway to determine the maximum use which can be made of the more economical feeds, hay silage and pasture in the production of milk (1947 Annual Report, page 52.) The results of the second grazing season (1948) bore out in many respects the results obtained in 1947 from the pasture phase of the study. A summary of the 2 years data of dry forage consumed per acre offers some interesting observations.

	1947	1948	Mean
Brome grass-Ladino	6555 lbs.	5819 lbs.	6187 lbs.
Ky. Bluegrass-White clover	2595	3592	3093
Reed canary grass-Ladino	5391	4553	4937
Tall oatgrass-Ladino	4585	4367	4476
Orchard grass-Ladino	7269	4483	5876

Some of the mixtures performed differently during these two years. On these characteristically poorly drained soils, orchard grass grew well throughout the summer of 1947, which had normal rainfall, hot and dry spells; whereas during the summer of 1948 nearly continuous heavy rainfall caused the orchard grass to become stunted and unproductive during most of the season. Bluegrass, on the other hand, was stimulated to much greater growth by the rainfall and cool temperatures.

Title: Small Grains for Fall and Spring Pasture

Leader: For the New Jersey Agricultural Experiment Station - M.A. Sprague

Trials undertaken to determine the use of small grains for pasture (1947 Annual Report page 54) were continued with the primary objective, the response of three grains, rye, wheat and oats, to fall and spring grazing practices. Data were collected on forage yields and subsequent yields of grain and straw.

The first harvest year (1947-48) offered some interesting results. In the case of each grain a single fall grazing materially increased the subsequent yield of grain over the areas not fall grazed. Likewise, a single spring grazing had a depressing effect on the yield of grain. Straw yields and test weights offered similar comparisons.

Fall and spring grazing of small grains can be expected to lengthen the pasture season up to 2 months in New Jersey. The forage yield of rye was approximately double that of wheat and oats during the fall and these differences in yield became more pronounced in the case of oats in the spring. The yield of a single spring grazing was approximately equal to the sum of fall and spring grazings for each species tested. Seedings were made in September 1948 for repeating these trials a second season.

Title: The Utilization of Potash and Nitrogen by Ladino Clover Under Grazing Conditions.

Leader: For the New Jersey Agricultural Experiment Station
M. A. Sprague

Plots were staked out and initial applications of potash made in the fall of 1948 on a 4 acre orchard grass-bluegrass pasture renovated in the spring of 1948 with Ladino clover. An excellent stand of clover was obtained and data collected indicated the ground covered by the clover in October averaged over 30 per cent. Three rates of potash were used, 50, 100 and 200 lbs. per acre per year with applications in October, April, split application in fall and spring, split application in April, June, August, October, and double applications in the fall in even years.

An over-all application of 250 pounds of 20% P_2O_5 per acre will be made each fall. To one half of each plot will be applied 150 pounds of N in 3 applications during the grazing season. Grazing will be accomplished by beef cattle in a moderate rotational grazing program. Forage samples will be taken prior to each grazing for mineral analysis. Clover populations will be determined annually with a grid quadrat.

This is a new experiment designed to answer a few of the questions surrounding the problem of keeping Ladino clover healthy in permanent grass sods.

Title: Grasses and Legumes for Poultry Range

Leaders: For the New Jersey Agricultural Experiment Station
C. S. Platt and M. A. Sprague

The benefits of range as a source of feed for poultry were observed for a third season (1947 Annual Report, page 53). The rates of gain of young birds were observed on Ladino, rye-grass, and blue grass ranges, on bare ground and in confinement. Quantities of grain and mash consumed were recorded and the birds were distributed to several different laying pens to determine the effects methods of rearing may have on the subsequent egg production.

The production of eggs by the 1947 birds raised on these ranges was determined from September 4, 1947 to July 31, 1948. More eggs per individual bird (162.5) were produced by birds raised to maturity on Ladino clover which was mowed than that which was not mowed (153.9); rye grass was second (158.3) and bluegrass least (153.3).

Title: A Study of the Response of Permanent Pasture Soils to Fertilization in New Jersey

Leader: E. R. Purvis

For the third successive year, a comparison of the yields from plots receiving no fertilizer with others receiving 500, 1000, and 2000 pounds per acre of a 5-10-10 mixture, indicates that only the 500 pound per acre application has resulted in profitable increases. This study is being conducted on three soil types, and the results from one location were entirely lost because of cattle breaking through the three strand barbed wire enclosure on four separate occasions. Since there was no shortage of pasture outside the plots, and since this tendency to break into the fertilized areas was noted at other locations, it is believed that this indicates a preference for the fertilized herbage on the part of the animals.

The results for the second year in the study where 1000 pounds per acre applications of 0-10-10, 5-10-10, 10-10-10, and 20-10-10, are being compared, indicate that the stand of clover is markedly reduced by the latter two mixtures. This study is being conducted at two locations with the plots being harvested four times during the season. Possibly a better stand of clover would be maintained with the high nitrogen applications by more frequent harvestings. Analyses for protein content from the 1947 harvests show that the high nitrogen applications produced grass having as much protein as Ladino clover taken from the no nitrogen plots, with the total protein yield, on an acre basis, being approximately 50% higher on the 20-10-10 than on the 0-10-10 plots.

The plant population of the pastures included in these studies consists of mixtures of bluegrass, Ladino clover, with some brome or orchard grass.

Title: Supplemental Irrigation on Pasture

Leaders: G. R. Blake, C. S. Garrison, E. R. Purvis, M. A. Sprague, and N. A. Willits

This study, started in 1947, to determine the advisability of using supplemental irrigation on improved pastures in New Jersey was continued through the summer of 1948. The major part of the experiment is conducted on an 8 acre field in Burlington County (1947 Annual Report, page 53). The only change of plans over the previous year was the substitution of two 400 pound applications of fertilizer in place of three 250 pound applications of three fertilizer ratios (0-10-10, 5-10-10 and 5-10-20).

Three irrigations of about 0.8" each were applied, two of which were soon followed by good rains. The third occurred during a late summer dry period and the yield of the last clipping (September 30) from the irrigated area was 28% greater than that from the unirrigated. There was no significant difference between the entire season's production on irrigated and non-irrigated areas. About three tons of dry matter per acre were obtained from each.

The per cent of grasses in the sward continued to increase, from 10% nine months after planting to 75% at the end of two years. There were no measurable differences with respect to fertilizer and irrigation treatments.

The yearly averages show that plots receiving 40 pounds N yielded 1000 pounds more dry matter than the plots receiving no nitrogen. One hundred and sixty pounds of potash gave no greater yields than 80 pounds under normal rainfall but there was evidence of some increase in yield from the higher applications of potash with irrigation.

CORNELL UNIVERSITY (NEW YORK) AGRICULTURAL EXPERIMENT STATION

Title: Breeding and Cytogenetic Investigations with the Forage Plants of New York

Leaders: S. S. Atwood and R. P. Murphy

This material will be presented here in the same order as in the previous reports. (1946 Annual Report, pages 57 and 58 and 1947 Annual Report, pages 56 and 57).

The red clover plants selected in the fall of 1946 from two-year old stands failed to survive in the field during the winter of 1947-48 and this phase of the study with red clover has been discontinued.

The inbreeding studies with bromegrass are being continued. Replicated ten-plant rows of 40 I_2 progenies were transplanted to the field in 1948. In addition ten I_1 progenies from superior clones in the polycross seed production nurseries were included. From the original I_1 nursery 234 selected I_1 clones and 36 selected clones from the Fischer checkrows were planted in 10 replications of spaced individual plants for clonal evaluation and polycross seed production. Three I_1 families which were found to be superior to the check variety, Fischer, were planted in 1948 in isolation for seed production of synthetic varieties as follows:

1. Synthetic E; 22 clones from I_1 family of 28-2
2. Synthetic F; 26 clones from I_1 family of 217-56
3. Synthetic G; 25 clones from I_1 family of 235-58
4. Synthetic H; 9 clones from I_1 family of 28-2, 11 clones from I_1 family of 217-56 and 10 clones from I_1 family of 235-58

Of the 192 self-sterile bromegrass clones planted in the 1946 polycross seed production nursery 108 were selected for progeny testing. These progenies were planted in June 1948 in pure stands in six replications of small broadcast plots. Several clones, although they were outstanding in vigor and headed profusely, failed to produce sufficient seed for an adequate progeny test. The range in seed production per plant by these 108 selected clones was from 2.5 grams to 57.9 grams. Experiments are planned and in progress in order to determine some of the causes for this variation in open-pollinated seed set. Cytological investigations of meiosis and observations on the flowering characteristics of these clones are included.

On the basis of clonal performance four synthetic varieties were planned and the parental clones of each planted in an isolated plot for seed production in 1949. These synthetics are as follows:

- Synthetic A; 13 clones for a recombination for recurrent selection and to test as a superior variety.
- Synthetic B; 5 clones for high aftermath production and low disease index to test as a superior variety.
- Synthetic C; 4 clones for high seed production to test as a superior variety.
- Synthetic D; 4 clones for low seed production.

The 240 clones of bromegrass planted in ten replications of spaced individual plants for polycross seed production in 1948 were studied intensively during the season. Sixty-two of these have been selected for planting in plots in 1949 for progeny testing. The 173 clones of bromegrass from the Pasture Laboratory were handled in the same manner and 37 were selected for progeny testing.

A study in bromegrass designed to observe the variation in the polycross progeny from ten selected heads from different replications in the polycross seed production nursery was started in 1948. These will be compared to bulked polycross progenies and asexual progenies for 20 clones.

The I_1 progenies of timothy and the 82 clones planted in the polycross seed production nursery in 1946 have been disappointing in performance and most of them will be discarded. A few of the best will be incorporated into the material selected in 1947 from the source nursery of timothy grown at Tully, N.Y. from seedlings started in 1946. From this nursery 240 selected clones were planted in 1948 in ten replications of spaced individual plants for clonal evaluation and for polycross seed production. The establishment of these clones was only fairly satisfactory. In addition these clones will be self-pollinated for the determination of their self-fertility and probably for the production of I_1 progenies.

The superior clones of tall oat grass have been maintained but no further breeding work was done in 1948. No I_2 progenies were started but the seed for these will be held in reserve for use when time and facilities make it possible to work on this species or when more interest in this species is expressed by agronomists.

The 284 selected clones of orchard grass, obtained from the Pasture Laboratory and established in eight replications of spaced individual plants in 1947, were studied intensively for clonal performance in 1948. One hundred and forty-three were selected for progeny testing in broadcast plots to be seeded in 1949. Many of the clones selected at Ithaca had also been selected at the Pasture Laboratory while many others had been selected at only one of the stations. Although no precise test could be made, it appears that there may be a significant clone x location interaction for several characteristics such as vigor, date of flowering and disease reaction. No winter killing was observed in the winter of 1947-48.

Rather general notes were taken in 1948 on the space-planted source nurseries of timothy, reed canary grass, meadow and tall fescue, and tall oat grass which were started at Tully, N.Y. in 1946. In addition to the 240 timothy plants noted above, 150 selected clones of reed canary grass were planted in 1948 in ten replications of spaced individual plants. The growth and establishment during the first summer was excellent. This first year establishment was better than that usually experienced with brome grass and was vastly superior to that experienced with timothy.

The selected clones of meadow and tall fescue and of tall oat grass will be maintained in reserve for future use if and when the need for breeding work with these species becomes apparent or when facilities are available for handling the additional material.

The Red Clover Uniform Disease Nursery was continued in 1948 and a new nursery established. No important differences in the varieties in their reaction to foliar diseases seems to exist except that the Wisconsin Mildew Resistant Selection is resistant to mildew. However, it is comparatively not more desirable in other characteristics.

The polycross progenies of the selected clones of Brage and S.143 orchard grass; of Svalöf Victoria, Danish EF 79 and Norwegian Jad-risk perennial rye grass; N.Y. creeping red fescue and a few clones of brome grass and tall oat grass which were planted in replicated 10-foot rows in 1947 were harvested three times for yield in 1948. (1947 Annual Report, page 58.) Although these data have not been summarized considerable variation among the progenies was apparent. Some of these clones in a study designed to investigate the variation in the performance of selfed progenies, polycross progenies and clonal progenies when planted as spaced plants; of polycross progenies and clonal progenies when planted in solid rows; and of polycross progenies

when planted alone in broadcast plots were harvested three times in 1948. The voluminous data from this study have not been completely analyzed but indications are that they are of considerable interest and the study will be continued in 1949.

The timothy clones of Cornell 1777 and 1059 are being maintained but the seed plots were plowed up after seed was harvested in 1947. Considerable seed is available but no effort to distribute this will be made as the varieties do not seem to be superior to present day varieties and commercial seed lots of timothy.

Ten of the best clones of zigzag clover from the 1944 plots were selected and replanted alone from cuttings in a replicated plot trial in 1948 for further observation.

Seedling plants of the polycross seed progenies of 18 of the Ladino clover clones included in the cooperative foundation seed planting in the West were transplanted to the field during the summer of 1948 in four replications of 10-plant rows in comparison with certified seed and several lots of imported seed from Italy. Observations in the fall of the first year indicated that most of the polycross seed progenies and importations produced predominantly Ladino-type plants. The plants from the imported seed were the most "gigas" in character but were less dense and spread more slowly than plants of the certified seed and the polycross progenies.

Title: Strain Testing and Breeding of Forage Plants for New York State and Vicinity with Special Emphasis on Problems of Production During Periods of Midsummer Drought.

Leaders: S.S. Atwood, R. P. Murphy, H. A. MacDonald, H. R. Fortmann, C. N. Hittle, and C. C. Lowe

The varietal plots seeded in 1945, 1946, and 1947 (1947 Annual Report, Pages 58-60) were harvested for yield in 1948, but only part of the results has been summarized so far. In most cases, the results over the three years have been of practical value in determining the establishment, persistence, yield, and other agronomic characters for the varieties included. The principal new varietal plots established at Ithaca in 1948 include red clover varieties, grown in 4 replications, dusted to control root borers, and in 4 replications, not dusted. Regional plots were also established at 6 new locations, in cooperation with the County Agents and the Extension Staffs in the Agronomy and Plant Breeding Departments. In Onondaga, Montgomery, and St. Lawrence Counties, these plots included 5 varieties of alfalfa, 1 variety of Lotus, 2 varieties of bromegrass, 1 variety of timothy, and 12 mixtures. The plots in Jefferson, Tompkins and Wyoming Counties included 3 varieties of Lotus, 1 variety of alfalfa, 4 varieties of timothy, 1 variety of bromegrass and 18 mixtures.

All of the conclusions reported last year have been confirmed, with Southern and Northern bromegrasses showing largest varietal differences. The Southern bromes have exceeded the Northerns in both hay and aftermath yield, and they appear to be more resistant to leafspots, particularly in the aftermath crops. The only contrary evidence was obtained at Churchville from the 1945 and 1946 seedings, where an unidentified root rot seemed to do more damage to the Southern than to the Northerns in midsummer, 1948.

The principal results from the study of aftermath growth of bromegrass at controlled high temperatures, in cooperation with the U.S. Plant, Soil, and Nutrition Laboratory, were reported at the A.S.A. Meetings in Fort Collins in August, 1948. Additional field data were obtained in 1948, and these will be incorporated into a final summary of this work.

The thesis study of Mr. Fortmann, on the response of five varieties of bromegrass to various nitrogen fertilization and cutting treatments is being summarized. A uniform treatment will be given to all plots in 1949 in order to conclude this study. The results so far show marked varietal response, as well as several interesting interactions of varieties x fertilizer, varieties x cutting treatments, varieties x crops, etc. However, the rank of the varieties was very similar under all treatments with the three Southern types (Fischer, Achenbach and Nebraska 40-3492), superior in yield to the two Northern types (Parkland and Wiley-Saskatchewan seed grower).

Title: The Evaluation of Birdsfoot Trefoil as a Forage Legume in New York

Leader: H.A. MacDonald

Progress: The birdsfoot trefoil investigations under way were continued during 1948. Under pasture management this legume produced higher yields of forage than did the white clovers during the drier part of the season. Where moisture and fertility were adequate, Ladino white clover was equal or superior to the Empire variety of birdsfoot trefoil.

Comparisons of various birdsfoot trefoil varieties and sources have been made during the past three years. Most of the material under study has proved to be quite winter hardy. Several varieties give promise of being high yielding and of particular value for use for hay and rotation grazing. The more erect types have not withstood continuous or close grazing as well as the Empire variety.

Several promising selections have been made and are now under further study and increase. These include both hay and pasture types.

Much effort has been given to studies relative to seed production. Early spring clipping and other improved management practices have resulted in greatly increased seed production.

Title: The effect of stage of growth upon the (1) nutritional value, (2) yield of hay and aftermath, and (3) longevity of stand of the principal forage grasses and legumes.

Leader: H.A. MacDonald

Progress: The data from the second replicated field seeding used in this study have now been assembled but have not been completely analyzed. This work is now in progress and the results will be made available in the near future.

In addition to the crops studied during the past few years, it is now planned to investigate several type varieties of the major grasses and legumes. Forage grasses and legumes not previously studied will also receive attention.

Title: The relationship of milk production to herbage characteristics from permanent and rotation pasture mixtures.

Leaders: Animal Husbandry: George Trimberger, J. Thomas Reid and K.S. Turk. Agronomy: R.E. Blaser, H.A. MacDonald and R. Bradfield

Object: To evaluate permanent and rotation pasture mixtures. Data on the following will be obtained: (a) Milk production per acre and per cow. (b) Seasonal carrying capacity. (c) Herbage consumption per cow. (d) Herbage production per acre. (e) Chemical composition of herbage and its relationship to digestibility. (f) Botanical composition (h) Cost of production.

Progress: Six lots of each of three mixtures are ready to initiate grazing in 1949. The mixtures are (1) permanent pasture (2) orchard grass and Ladino clover and (3) brome grass, Ladino clover and alfalfa. The latter two mixtures will be plowed up and resown in oats every four years. The mixtures will be grazed alternately. Any one group of cows will graze only one mixture, i.e. alternate grazing will be practiced within a mixture.

Title: Factors which influence the longevity, seasonal growth and productivity of Ladino Clover.

Leaders: R. E. Blaser and E. M. Kroth

Treatments to measure the effect of fall cutting management of Ladino clover were imposed on a three year old stand. As clipping intensities during September and October were increased, the spring growth of Ladino was decreased. On plots where the growth was accumulated during September and October, removal of the herbage in late October did not have an adverse effect on Ladino clover during the 1947-48 winter.

The effect of aftermath fertilization on the yield, botanical and chemical composition of a grass-Ladino clover association has been studied for two years. On this soil, Ladino clover yield increases were associated primarily with potassium fertilization. Increases in grass

yields were associated with nitrogen fertilization. The total yields from an 0-0-50, 0-100-50 and 50-100-50 were of similar magnitude. The highest yields were obtained from an 0-100-100 treatment.

The data indicate that Ladino clover is retarded because of nutrient competition. Nitrogen fertilizer stimulated the growth of grasses which seem to absorb most of the available potash. The clover population is then reduced because of potassium starvation.

A supplementary experiment indicates that a satisfactory Ladino clover population can be maintained under high levels of nitrogen fertilization, provided that an adequate supply of potash is made available.

Cooperative tests indicate that certain soil constituents are sufficiently low to cause a low Ladino clover population and yield on some soils. Rates and frequencies of applying phosphorus and potassium on the growth and botanical and chemical composition are to be determined.

Title: Herbage quality and quantity for forage species grown under various New York environments

Leaders: R. E. Blaser, R. Bradfield and H. A. MacDonald

In an experiment, established in August, 1947, three grasses (brome, timothy and red top) were sown separately with each of three legumes (Ladino, birdsfoot trefoil and alfalfa). Yields of the aftermath growth were taken, the first cutting being discarded because of contamination with volunteer rye. Mixtures with alfalfa produced the highest aftermath yields. All of the grasses produced low aftermath yields.

Two experiments were established to associate method and rate of sowing grasses with the longevity and productivity of the leguminous associate. The grasses were sown broadcast and in the row at different seeding rates and the legumes were broadcast. Several seeding rates of Ladino clover were used. Cutting management variables will be practiced. The data are not yet summarized, but field observations indicated that sowing grasses in rows will reduce grass competition when compared with broadcast sowings, particularly in the case of Ladino clover.

One test was established on an old meadow which was initially seeded to timothy and Ladino clover. The meadow was in a low state of productivity, the Ladino clover population making up less than three percent of the vegetation. Fertilizer treatments were used to measure the relative yields from nitrogen fertilizers as compared with non-nitrogenous fertilizer treatments. The success of the latter treatments will depend upon the magnitude of the Ladino clover.

ENTOMOLOGY

Title: Alfalfa Snout Beetle Investigation

Leaders: George G. Gyrisco and D. S. Marshall

During 1948, several tests using chlorinated hydrocarbons and organic phosphates in small plot field experiments and large air application tests by rotary and fixed winged aircraft were initiated in Jefferson County.

In the hand dusted plots nine different dust materials, some at several levels of concentration were compared with the standard peanut shell bait in order to determine the most effective level of concentration and formulation for the control of the alfalfa snout beetle. BHC and parathion as one per cent dusts were the most promising materials tested, while chlordan was not effective at the low concentration of one per cent impregnated dust at which it was used. DDT, which appeared to be more effective as an impregnated dust, DDD and the two proprietary piperonyl cyclonene dusts were not as effective as the standard peanut shell bait. Ten per cent chlorinated camphene dust showed some promise at that concentration.

The five most promising dust formulations, DDT, chlordan, parathion, chlorinated camphene and BHC, were selected from the hand plots described in the experiment above and applied by means of a Bell helicopter to a 15 acre block of freshly plowed infested alfalfa ground. Although good kills from 80 to 100 per cent were obtained, a reinfestation occurred about three weeks after treatment indicating that at least two applications of insecticide are necessary; one at prepeak and one at peak beetle emergence.

In another trial three adjacent fields were treated with a Stearman biplane using 5 per cent DDT, 5 per cent chlordan and 3 per cent gamma BHC dusts. As in 1947, chlordan gave excellent results and was the most effective material used. DDT and BHC in this experiment were very disappointing.

Title: Clover Root Borer Studies

Leaders: George G. Gyrisco and D. S. Marshall

Further studies were continued on the life history and biology of the clover root borer indicating that in the first crop or first cutting year about 40 per cent of the clover roots were infested with an average of 1.5 borers per plant. In the second crop year the infestation was nearly 100% with an average of 3.8 borers per plant.

During 1948 three tests involving several acres showed that the clover root borer can be controlled by a single well-timed application (during peak migration of the beetles) of benzene hexachloride dust. BHC did not

reduce the palatability of the hay to livestock. Parathion and chlordan as dusts in that order gave high degrees of control also; however, they were not as consistent in their results as BHC. DDT dust was not as satisfactory as the other synthetic organic insecticides.

Since residues from the use of insecticides potentially hazardous to livestock, man, honeybees and other pollinating insects are one of the greatest limiting factors in the use of insecticides on forage crops, residue determinations were made of all the hay from the treated plots. Less than 1.0 ppm of toxic was found at hay cutting time; however, more information is needed on the fate of these residues in the cow and their appearance in milk and butterfat before any recommendations can be made.

Title: European Chafer Studies

Leaders: George G. Gyrisco and D. S. Marshall

A survey was made of 47 towns and villages in 4 counties near Newark, N.Y. in order to determine the area of infestation of the European chafer. The survey showed that there has been an extension of the infestation to the west and southwest of Newark, N.Y. for several miles and that the infestation now encompasses an area greater than 150 square miles.

In several cage and field tests during 1948, the grubs of the European chafer were effectively controlled by both BHC and chlordan applied as dusts to the soil. BHC was used at the rate of 1 pound of gamma isomer per acre, while chlordan was most effective at the rate of 10 pounds per acre. Parathion, DDT and chlorinated camphene were also used with less satisfactory results.

Preliminary tests with a thermal aerosol machine indicated the possibility of its use for controlling the adult beetles during mating flights. A fog made from 5 per cent DDT in an oil gave spectacular kills of thousands of adults in a single trial made.

Title: White Grub Studies

Leaders: George G. Gyrisco and D. S. Marshall

An extensive survey of thirteen counties which included Erie, Niagara, Orleans, Monroe, Wayne, Cortland, Oswego, Jefferson, Clinton, Franklin, St. Lawrence, Essex and Steuben in western and northern New York, formerly infested with white grubs, was made. This survey failed to disclose any infestations serious enough to warrant any treatments.

Brood C, which makes up most of our white grub infestations, should be in flight in 1949, yet late third instar grubs, pupae and inactive adults were difficult to find in the Champlain Valley, near Bath and Buffalo where this brood has occurred in large numbers in the past.

Extreme conditions of drought for several of the past few years in western and northern New York are believed to be responsible for the great reduction in population of these grubs, since extreme dry weather for prolonged periods is known to destroy large numbers of immature larvae.

Preliminary tests with several chlorinated hydrocarbons indicated that BHC and chlordan might effectively be substituted for lead arsenate in the treatment of white grubs. Further work with heavier infestation is needed, however, before any recommendations can be made.

Title: Resistance of Alfalfa to Insects

Leaders: S. S. Atwood, George G. Gyrisco, R. P. Murphy and D. S. Marshall

During 1948 a cooperative project with the Department of Plant Breeding was initiated. Two hundred and sixty-one varietal clones were systematically tested in the laboratory for resistance to pea aphid. Further resistance tests with potato leafhopper and meadow spittlebug are anticipated in the future.

Early results indicated that some clones are so resistant that all the aphids will die rather than feed on them when confined to the plants in cages. Other plants were so susceptible that 10 individuals increased to over 330 individuals in 1 week.

RHODE ISLAND AGRICULTURAL EXPERIMENT STATION

Title: The Response of Strains and Mixtures of Forage Plants to Grazing

Leader: Irene H. Stuckey

Yields on these plots were reduced by amounts ranging from 20 to 50% of the totals for the 1947 season, but since the yields for May, June and July were very nearly the same as those for 1947, the difference would appear to have been caused by drought rather than to age of the stands.

Ladino clover in combination with Lincoln or a Canadian brome grass, commercial orchard grass or perennial ryegrass continued to be most satisfactory in terms of yield and palatability, and in maintaining the legume. Reed canary grass was noticeably unpalatable to the heifers except during the June grazing period when the stems were elongating rapidly. The birdsfoot trefoil plot has been invaded by Ladino clover

to the extent that 50% of the legume plants in the plot are now Ladino clover. When the drought became severe, the wilting point of both species was the same, plants growing on more gravelly areas in the field succumbing first. The evidence is accumulating that for sandy soils in Rhode Island; at least, birdsfoot trefoil offers no advantage over Ladino clover.

VERMONT AGRICULTURAL EXPERIMENT STATION

Title: Cytogenetics and Breeding Investigations with Forage Legumes

Leader: A. Gershoy

T. repens var. giganteum, $8n=64$. Octoploid Ladino clover.

The objective is to produce a high yielding, composite forage strain. Obviously octoploids will not hybridize with wild white clover nor with commercial Ladino. Plants produced in 1946 and 1947 were left in the field for observation in 1948. About 1500 seedlings, first grown for several months in the greenhouse, were set out in progeny rows, in 1948. These were derived from best parents (primary octoploids) isolated in a polycross nursery and from F-1 and F-2 open-pollinated, superior parents grown in a general source nursery. Several primary selections were made in 1948 in the greenhouse on the basis of vigor and conformity with a spreading type of growth. Thus, slow growing seedlings were, in part, eliminated. The 1948 seedlings not only compared favorably with best parent types but an appreciable number of them also appeared to possess superior combinations of such characters as aggressiveness, size of plant parts and ability to root well.

Two additional clonal polycross nurseries were set out in isolation in 1948. One of these was composed entirely of tall, compactly growing types with large, somewhat furled leaves; the other consisted of clones with various combinations of vegetative and floral characteristics.

Periodic field observations of 1946 and 1947 parent clones, as well as of the 1948 seedlings, indicate that there is a decided range in seasonal response to temperature, moisture and soil conditions. A small number of parent clones judged as superior in 1946 and 1947 grew aggressively enough, in a 4 foot spacing in progeny rows, to form in 1948 a continuous ground cover that compared favorably with stands of standard Ladino of similar age in grass association.

Incomplete sampling analysis indicates that seed production in octoploids remains at a consistently high level in heterozygous, field populations. Seed count ranges from 1-4, often 2 per pod. For example: a flower head of 142 florets contained 323 seeds, the lowermost and uppermost florets unpollinated. Similarly counts averaging over 200 per head of 160 florets have been recorded in some clones. However, under field conditions seed heads gathered from standard, tetraploid Ladino late in September showed a higher count than in octoploids.

When low seed set is observed in octoploids late in the growing season it appears likely that the causal factor is a lack of bee visits rather than the presence of genetic factors for abortive sterility. It is of practical interest to point out that, in octoploids, flower stalks tend to remain more erect than standard Ladino after full ripening of the seed.

Comparison of seeded areas in poultry ranges and small field plots shows the presence of a fairly high percentage of hard seeds in octoploids threshed under laboratory conditions as contrasted with machine threshed standard Ladino. In their present state of genetic improvement octoploids generally show a less aggressive spread than commercial tetraploids. Field studies on a larger scale are in progress and will be continued as genetic improvement proceeds. Projected work in 1949 includes additional polycross tests, production of specific genetic combinations, observations in new progeny rows and increase of seed for farm trials.

Lotus corniculatus var. vulgaris. Broad leaf Birds foot trefoil.

The original parent stocks were derived from seeds of tall, European strains. The forage type being sought is a mammoth, high yielding, dual purpose, hay-pasture strain. Approximately 1500 seedlings have been under observation in 1948 in progeny rows. These were derived from 10 best parents grown in an isolated polycross nursery. Periodic field observations indicate a decided genetic improvement in type as compared with plants observed in an original source nursery. These 1948 seedlings also showed a surprising uniformity in such desirable characters as height, thickness of stem, size of leaves, time of flowering and ripening of seeds, but a lack of uniformity as to presence of winter rosettes. The relation of these to winter hardiness is being studied. In contrast, the seedlings grown in the original source nursery were quite heterogeneous in regard to vegetative and floral characteristics.

A second polycross nursery, planted with seed from the best parents grown in 1948 will be set out in 1949. Field studies designed to test the adaptation of mammoth plants to soil types are in progress and will be continued on a larger scale as genetic improvement proceeds.

Lotus tenuis, $4n=24$. Autotetraploid, Narrow leaf birds foot trefoil. The objective is to improve the forage qualities by increasing size of plants and leaves. Tetraploid plants have been found to be winter hardy. Seed set is, variably, low. Size of plants is equal to, or exceeds that of best commercial diploid plants. Leaf size is generally larger than in diploids. Progeny rows, derived from open-pollinated parents will be under observation in 1949.

Lotus uliginosus, $4n=24$. Autotetraploid Big trefoil. The objective is to determine if tetraploid clones possess winter hardiness, lacking in commercial diploids. A small number of tetraploids, of low fertility, have been grown in the field in 1948. These have been

left quite exposed to winter injury in the field. Recent field observations indicate that all portions of the plants above ground have been winter killed. From observations in the spring of 1949 it will be determined if these plants will have recovered, with sufficient vigor to produce adequate forage.

T. medium. Zig ~~Ag~~ clover.

Polycross nurseries have been set out, composed of the superior parents selected from a large number of field grown clones. Progeny row studies will be continued in 1949. Seed increase, from best parents, is planned, for study of this species under farm conditions.

T. fragiferum, $4n=32$. Autotetraploid Strawberry clover.

The objectives of this study are: 1. Synthesis of a larger, more productive forage type. 2. Cytogenetic analysis, in an autopolyploid of an obligately autogamous species. Cytogenetic studies are in progress. An effort is being made to isolate plants producing a high seed set as a preliminary to the synthesis of a desirable forage strain.

WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION

Title: Pasture Fertilization Studies

Leaders: F. W. Schaller and G. G. Pohlman

Analyses of soil and plant samples were completed and the results are being summarized for publication. Protein content of the herbage was closely related to the amount of white clover in the forage. Yields were influenced markedly by rainfall. In seasons of normal rainfall the yield was closely related to the rate of phosphate application.

Title: Maintaining Profitable Stands of Alfalfa

Leaders: F. W. Schaller and John R. Webb

Objectives: 1. To determine the causes of failure of alfalfa stands under various soil and management conditions. 2. To find methods of prolonging the life of alfalfa stands.

Soil samples were taken from a number of fields of alfalfa. These are being analyzed in the laboratory. Thus far the results indicate that soils on which alfalfa stands are long lived usually are relatively high in pH in the lower subsoil. Some soils have been found which had a very high available phosphorus (Truog test) in the subsoil but these have not shown especially old alfalfa stands except where lime occurs in the subsoil.

Three areas were seeded to alfalfa in the spring of 1948. Various rates and methods of application of lime and phosphate were used. Yield records will be obtained in 1949.

Title: Ladino clover

Leader: F. W. Schaller

Three seedings of Ladino clover grass mixture were made in 1948. Differential treatments included different grasses (brome grass, timothy, and orchard grass) and different fertilizer treatment. The plots receiving nitrogen in addition to phosphorus and potash made the greatest growth in 1948.

Controlled grazing of one area of orchard grass, Ladino clover and alfalfa and one area of brome grass, Ladino clover and alfalfa was observed and yield records taken. In terms of dry hay, the plots yielded 3.8 and 4.3 tons per acre respectively. The plots were grazed with Ayrshire and Jersey cattle. The cattle received grain in addition to the pasture according to their milk production. Under these conditions, the orchard grass-Ladino clover-alfalfa plot furnished 549 days of grazing per acre and the brome grass-Ladino clover-alfalfa plot gave 451 days of grazing per acre.

Title: Mid-Summer Pasture at the West Virginia University Dairy Farm 1948.

Leader: F. W. Schaller

The University Dairy Farm has been feeding high producing dairy cows for many years. They have found that to do this at the lowest cost they must have lots of good hay and pasture. They have also found that this hay and pasture must be of the very best quality. It must be high in feed value and it must be relished by the cattle. Top this with a high yield per acre and you have the basis for profitable dairy feeding.

Two fields on the Dairy Farm which have been very successful in producing high yields of good hay and also an abundance of mid-summer pasture are described below:

Seed Mixture Used

Field 1	Lbs. per acre	Field 2	Lbs. per acre
Orchard grass	6	Bromegrass	6
Ladino clover	2	Ladino clover	2
Alfalfa	10	Alfalfa	10

It is now believed that more desirable stands can be obtained by using 5 lbs. per acre of orchard grass and 10 lbs. per acre of bromegrass in place of the above rates. Also Ladino clover at the rate of 1 lb. per acre is usually sufficient when used in the above mixtures.

Fertilization and Seeding

Both fields were prepared in late August of 1946 following a crop of Sudan grass. A good application of manure (10-12 tons per acre) was plowed down. 500 lbs. per acre of superphosphate was applied on the surface and worked in. Sufficient lime had already been applied.

The seed was broadcast on a firm seed bed and cultipacked.

Additional manure and 300-400 lbs. per acre of 0-14-7 fertilizer are applied each year.

Harvesting the Crop

The first crop is removed for hay or silage about the middle of May and the succeeding crops are used as pasture. Grazing is carefully controlled. The herd is first turned in when the forage is 10-12 inches tall. The cattle eat their fill in about 2 hours of grazing and are never allowed to loaf on the pasture. When the forage has been grazed down to 3 or 4 inches, the area is clipped and the cattle are kept off until the growth is again back to 10-12 inches. Approximately 3 grazing periods are obtained in this manner each year.

Yield and Protein Content of Forage Obtained in Three Cuttings 1948

	Field 1				Field 2			
	Orchard grass-				Brome grass-			
	Alfalfa-Ladino Clover				Alfalfa-Ladino Clover			
	May	June	Aug.		May	July	Sept.	
Harvest dates*	10	24	11	Total	18	6	2	Total
Tons per acre green forage	9.6	5.5	4.3	19.4	11.0	7.0	3.6	21.6
Tons per acre hay	1.8	1.1	0.9	3.8	1.9	1.5	0.9	4.3
Per cent grass in hay	78.0	62.1	61.6		70.2	78.7	63.4	
Per cent alfalfa in hay	10.7	14.9	4.8		20.5	15.0	28.0	
Per cent Ladino in hay	11.3	23.0	33.6		9.3	6.3	8.6	
Per cent protein in grass	14.2	14.4	14.4		15.4	13.7	17.5	
Per cent protein in alfalfa	24.4	17.6	21.8		23.1	15.3	20.6	
Per cent protein in Ladino	25.6	20.7	23.4		25.0	17.9	21.6	
Av. Per cent protein in hay	16.6	16.3	17.8		16.9	14.2	18.7	
Lbs. per acre protein	598	359	320	1277	642	426	337	1405

*The first cutting was made into hay and the remaining growth was grazed by dairy cattle.

Grazing data

The Ayshire and Jersey herd were given one full feed per day on the supplementary pastures listed below. The cows would eat their fill in about 2 hours of grazing. During the rest of the day and at night they were kept on permanent pasture. In addition to pasture all were fed grain according to their milk production. No hay or silage was fed at any time.

The use of these supplementary pastures was very important in keeping milk production high during the mid-summer period.

The grazing data in the following table give some further information on the production of the two grass-legume pastures. The grazing obtained during one period on a 6-acre Sudan grass pasture is also shown.

	Field 1	Field 2	
	Orchard grass- Alfalfa-Ladino Clover	Bromegrass-Alfalfa Ladino Clover	Sudan grass
Acres in pasture	3	3	6
First grazing period	June 25 to July 7	July 8 to July 24	July 25 to Aug. 12
Days on pasture	12	18	18
Number of cows	55	47	52
Second grazing period	Aug. 13 to Sept. 9	Sept. 10 to Sept. 22	
Days on pasture	29	13	
Number of cows	34	39	

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